TEXTILE RESEARCH

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The Editor's Page

Research Salesmanship: An Institute Problem

THE most difficult problem to be solved by U. S. Institute for Textile Research is not a research, but a merchandising problem—the sale of the research idea to the industry.

This was realized by the organizers of the Institute in 1930, and prior to that by those members of the Textile Research Council and of the American Association of Textile Chemists and Colorists who were chiefly responsible for the founding of the Institute.

Although the original 50 members have grown to nearly 300, and although some 500 representatives of the industry receive our magazine regularly, this merchandising problem looms as large as ever.

Although our first research conference attracted less than 50 interested persons, the warp sizing conference last year more than 100, with the resultant financing and organizing of that research, and the recent conference on rayon crêping problems more than 225, the selling of the research idea, as embodied in the purposes and services of the Institute, remains the latter's major problem.

It was agreed by many who attended the last two conferences that they effectively demonstrated the profound general ignorance in the industry of the underlying fundamentals. Must these demonstrations be applied to every textile process to awaken their operators to their need of scientific research?

Four examples of the practical application in the industry of recent scientific research findings were described at our annual dinner last month, the general utilization of which by mills for which they are adapted would result in large annual economies. They are available to any manufacturer who has the intelligence to apply them. Must every "doubting Thomas" have such a gift forced upon him before he will support research co-operatively?

(*Editorial continued on page 103*)

Institute's Sixth Annual Meeting

Research Conference and Dinner Attract Record Attendance

WHILE the annual meeting of United States Institute for Textile Research, Inc., the research conference on rayon crêping problems, and the Institute's first annual dinner, which were held at the Waldorf-Astoria, New York, N. Y., Thursday, Nov. 14, marked the end of the organization's first five years in a fitting manner, no attempt was made to celebrate the event in a formal way; in fact, there was no direct reference to it in any of the reports or by any of the speakers. The reason? Realization by directors, officers and active committees that the plans formulated in 1930 are two or three years behind the original schedule; this being a result of the general business depression suffered by all industry during this period.

Yet, had this meeting been planned as a formal celebration of the anniversary, with emphasis upon the Institute's five years of service to the textile industry, it is highly doubtful that the demonstration would have been any more impressive than that actually given, or that the attendance of more than 300 members and guests would have been much larger or more representative of that part of the industry that is research-minded. Those who attended the annual meeting, research conference and dinner saw and heard a practical demonstration of how the Institute works and, thanks to our guest speaker, Dr. Robert Andrews Millikan, how scientific research operates to the profit of industry.

Some Notable Features and Actions

Exclusive of meetings of the Board of Directors at 10 A. M. and 1 P. M., the program provided for the annual meeting of the corporation (members) at 11 A. M., a research conference on rayon crêping problems at 2 P.M., and a dinner at 7 P. M.

The most important features of the annual meeting were

the adoption of amendments to the by-laws which gave increased recognition of scientists and technicians on the Board of Directors and as officers, and that also made the Research Council a standing committee succeeding the old research committee; the report of the directors noting the successful completion last March, with the aid of the Textile Foundation, of the financing of a two-year study of warp sizing, now in progress at Massachusetts Institute of Technology; and the Secretary's report noting a substantial increase in membership, particularly of the contributing class ($100 a year), which class qualifies to receive confidential progress reports of researches. Of notable interest, also, was the report of Chairman Fessenden S. Blanchard of the committee on economic research describing a proposed study of the vertical integration of textile merchandising and manufacturing, which that committee believes can be financed and organized.

The conference on rayon crêping problems, scheduled to be held in the Jansen Suite which seats 175 comfortably, attracted an attendance of more than 225 and had to be transferred to the Astor Gallery. Starting at 2 P. M., the discussion of the many problems involved lasted until 5 o'clock, and it was then evident that, while several new problems for research had emerged, it could have been profitably protracted for several more hours.

The feature of the dinner, which was given in the Astor Gallery at 7 P. M., was, of course, the inspiring address of Dr. Robert Andrews Millikan on "Whither Scientific Research in Industry?" The adjournment of the annual meeting from the first Thursday in November, as provided in the by-laws, to Nov. 14 was for the specific purpose of giving members and guests the opportunity of hearing Dr. Millikan and of having him as our honored guest. While the balance of the speaking program was of unusual interest and importance, it is safe to credit Dr. Millikan with having attracted a much larger attendance than advance reservations indicated, and that included more than 200 members and guests.

Directors and Officers Elected

To facilitate action of the Corporation in the election of directors to succeed those whose terms had expired, the Board of Directors had appointed in advance the following Committee on Nominations and their report was accepted by the Corporation: Dr. Robert E. Rose, Chairman, Joseph Bancroft, Alban Eavenson. The committee's report on nominations of officers for the current fiscal year was also accepted by the Board of Directors. The directors and officers elected were as follows: President, Hon. Francis P. Garvan; Vice-Presidents: Dr. E. H. Killheffer, Dr. H. DeW. Smith, Prof. L. A. Olney, Alban Eavenson, Prof. E. R. Schwarz; Treasurer, Ernest N. Hood; Secretary, Charles H. Clark; Executive Committee: Dr. E. H. Killheffer, Chm., Alban Eavenson, Ernest N. Hood, Joseph Bancroft, P. A. Johnson, Dr. Robert E. Rose, Dr. H. DeW. Smith, Dr. W. E. Emley, Prof. E. R. Schwarz.

Directors for terms expiring in 1938: James T. Broadbent, Pres., Standard Textile Products Co.; Alban Eavenson, Pres., Eavenson & Levering Co.; Hon. Francis P. Garvan, Pres., The Chemical Foundation, Inc.; Ernest N. Hood, Treas., Pequot Mills; Weston Howland, Pres., Warwick Mills; Dr. E. H. Killheffer, E. I. du Pont de Nemours & Co.; W. S. Libbey, Treas., W. S. Libbey Co.; Prof. Louis A. Olney, Lowell (Mass.) Textile Institute.

Succeeding Alfred L. Lustig, deceased, for term expiring in 1936, Warren E. Emley, chairman, U. S. Institute Research Council, and Chief Organic and Fibrous Materials Div., Bureau of Standards, Washington, D. C. Succeeding Thomas T. Clark, resigned, for term expiring in 1936, Edward R. Schwarz, Associate Professor of Textile Technology, Massachusetts Institute of Technology, Cambridge, Mass., and also Chairman, Board of Editors and Committee on Abstracts and Bibliography for the magazine, *Textile Research.*

New Members Elected

The following is a list of new Contributing and Annual members elected by the Board of Directors at their meetings Sept. 27 and Nov. 14:

Contributing

American Bemberg Corp., Elizabethton, Tenn.
Arnold, Hoffman & Co., Providence, R. I.
Atlantic Gelatin Co., Inc., Woburn, Mass.
Atlantic Refining Co., Philadelphia, Pa.
Berkshire Fine Spinning Associates, Fall River, Mass.
Bigelow-Sanford Carpet Co., Thompsonville, Conn.
Victor G. Bloede Co., Inc., Baltimore, Md.
Bloomsburg Silk Mill, Bloomsburg, Pa.
Drake Corp., Norfolk, Va.
Fairforest Finishing Co., Spartanburg, S. C.
Farr Alpaca Co., Holyoke, Mass.
Foxboro Co., Foxboro, Mass.
Hart Products Corp., New York, N. Y.
Kali Mfg. Co., Philadelphia, Pa.
Keever Starch Co., Columbus, Ohio.
Milligan & Higgins Corp., New York, N. Y.
Monsanto Chemical Co., St. Louis, Mo.
Morningstar, Nicol, Inc., New York, N. Y.
National Adhesives Corp., New York, N. Y.
North American Rayon Corp., Elizabethton, Tenn.
Penick & Ford, Ltd., New York, N. Y.
Texas Co., New York, N. Y.
Tubize Chatillon Corp., New York, N. Y.
United Chemical & Organic Products Corp., Chicago, Ill.
Waypoyset Mfg. Co., Central Falls, R. I.
Paul Whitin Mfg. Co., Northbridge, Mass.

Annual

Stanley B. Hunt, Textile Economics Bureau, New York, N. Y.
Harry D. Learnard, Pacific Mills, Lawrence, Mass.
Claxton Monro, Andover, Mass.
E. W. Montgomery Co., Greenville, S. C.
Pinehurst Silk Mills, Hemp, N. C.
Proctor & Gamble Co., Ivorydale, Ohio.
Dr. R. E. Rupp, Pacific Mills, Lyman, S. C.
H. Schindler & Co., Inc., Canton, Mass.

Soluol Corp., Providence, R. I.
Swift & Co., Chicago, Ill.
Throwsters Research Institute, Inc., New York, N. Y.

Committees

Committee on Meeting: William W. Buffum, chairman; Dr. H. DeW. Smith, Prof. E. R. Schwarz and C. H. Clark.

Committee on Conference: Dr. H. DeW. Smith, chairman; H. E. Bishop, B. L. Hathorne and C. H. Clark.

Nominating Committee: Dr. Robert E. Rose, chairman; Joseph Bancroft and Alban Eavenson.

Annual Meeting of the Corporation

IN the absence of the President the annual meeting of the Corporation was called to order by First Vice-President Eavenson at 11 A. M. in the Jansen Suite. The Secretary reported the attendance in person and by proxy of more than a legal quorum, and the meeting was declared ready for business. The agenda was acted upon as follows:

(1) Minutes of the last meeting, having been received by all members, were ordered approved without reading.

(2) The report of the Board of Directors, as read by the Secretary, was accepted to be placed on file.

(3) The report of the Treasurer, as read by the chairman, was accepted to be placed on file. (The Treasurer reported receipts of $15,051.92, and expenses of $13,967.90, leaving a debit balance of $1,084.02. The balance sheet showed assets of $3,408.99, and cash and accrued interest available for use of $1,408.99.)

(4) The report of the Auditor (William W. Buffum) as read by the Secretary, was accepted and ordered filed.

(5) The report of the Secretary was approved and ordered filed.

(6) The report of Chairman Emley of the Research Council, as read by Chairman Eavenson, was accepted, Chairman Eavenson noting that Dr. Emley's absence was due to a call for military duty.

The reports of Chairman Blanchard of the Committee on Economic Research, and of Chairman Bolton of the Warp Sizing Administration Committee, as presented by them, were accepted.

Amendments to By-Laws

(7) The following amendments to the by-laws, as read by the Secretary and as submitted by him to all members of the Corporation 30 days prior to Thursday, Nov. 7, in accordance with the by-laws, were ordered approved by unanimous vote of those members present.

Article II, Section 2. (Page 4) Enumeration of Committees. There shall be three standing or permanent committees; one designated as the "Executive Committee," which shall consist of not more than 12 members and the president ex officio; another designated as the "Board of Trustees," which shall consist of six members and the president ex officio; another designated as the "Research Council," which shall consist of not less than five members.

Section 3. (Page 5) Election of Directors. At the end of this paragraph insert the following: The chairman of the "Research Council" shall be a director.

Section 5 (a). (Page 6) Election of Executive Committee. At the end of this paragraph insert the following: The director who is the chairman of the "Research Council" shall be a member of the "Executive Committee."

(8) Chairman Eavenson stated that a Nominating Committee had been appointed in advance of this meeting to present a list of nominees and thus facilitate action of the meeting, and it was voted that this Committee be accepted to act for the meeting in this capacity. Chairman Rose having presented the committee's report, it was then

(9) Voted: That the report of the Nominating Committee be accepted, that nominations be closed and that the Secretary cast one ballot for the ticket reported.

New Business

(10) No items of new business being reported, Chairman Eavenson drew attention to the presence of several guests, and to the fact that the Institute was notably honored by the attendance of Chairman Franklin W. Hobbs and Treasurer Stuart W. Cramer of the Textile Foundation. Before introducing them he spoke briefly of the work and objectives of the Institute, and of his belief that both organizations could find mutual benefit in even closer co-operation than heretofore, and that Institute problems financed by the Foundation must necessarily lead to better mutual understanding and co-operation.

Mr. Hobbs wished it understood that he was present as a Contributing member of the Institute through the Arlington Mills, of which he is president, as well as a representative of the Textile Foundation. He stated that he is following the warp sizing research, which the Foundation and Institute are financing on a 50–50 basis, with keen interest. He referred to the difficulty encountered by the Foundation in finding and selecting appropriate subjects for research, noting that they have an advisory committee to aid in this work with which two U. S. Institute members are associated—Dr. Rose and Prof. Schwarz. At a recent meeting they had present, in addition to the advisory committee, the presidents of several of the trade associations. He referred to the Foundation's efforts to improve the work and the product of the textile schools, with which efforts the heads of the schools are working harmoniously. He admitted that there was much of the reported Foundation research that he, and probably many others, did not understand, but that the Foundation has asked Prof. Schwarz and others to interpret these reports in language that will be understood by a larger percentage of those who should profit by them.

Mr. Cramer expressed his pleasure at being able to be present, and his interest in Institute work. The getting of research results before the public in an understandable form is a problem that must be solved by both the Foundation and the Institute. "I feel," he said, "that the arrangement by which our research reports are published in your magazine is a happy solution of at least a part of the problem."

As moved by Mr. Buffum and seconded by Prof. Olney it was unanimously voted to extend formal thanks to the Textile Foundation for their aid to U. S. Institute for Textile Research.

Among others who spoke briefly were Prof. Olney of Lowell Textile Institute, Dr. E. W. France of the Philadelphia Textile School and Dr. J. R. Katz, director of the Institute's warp sizing research. The latter, who had returned recently from a European trip, referred to the large amount of research work that had been done on sizing in Europe, and particularly in England by the British Cotton Industry Research Association. The latter has been working on sizing problems for some ten years, and still has a completely equipped laboratory and large force at work. Results to date are reported of great practical value, but all reports are of a confidential nature, available only to those members financing the work.

The meeting adjourned at 12:45 P. M.

Annual Report of Board of Directors

YOUR Board of Directors at their first quarterly meeting, Nov. 1, 1934, elected the following officers and members of the Executive Committee and received their acceptances: President, Hon. Francis P. Garvan; Vice-Presidents: Alban Eavenson, Louis A. Olney, H. M. Chase, Thomas T. Clark, A. L. Lustig; Treasurer, Ernest N. Hood; Secretary, Charles H. Clark; Executive Committee: Alban Eavenson, Ernest N. Hood, Joseph Bancroft, Philip A. Johnson, Robert E. Rose, H. DeWitt Smith.

Your Directors and Executive Committee held three other joint meetings during the year—Feb. 15, Sept. 27 and Nov. 14, all in New York City.

Your books of account have been audited by Mr. William W. Buffum and his certificate of their correctness has been accepted and filed. Your Treasurer's report for the last fiscal year shows the largest debit balance in our history, although pitifully small compared with the sum that could be utilized in new research. Your budget for the last fiscal year was closely approximated in all regular items. Your budget for the current fiscal year shows no material increase in normal expenses, but includes increases in receipts to cover the warp sizing research that are already provided for, and which it is hoped will balance expenses for that project. A budgeted increase in membership dues is included which, if it materializes, may be sufficient to take care of an unpredictable expense increase.

Notwithstanding the fact that we closed the 1933–34 fiscal year with an increase in membership of 65%, and in income from memberships of 62%, and had obligated U. S. Institute as the outcome of the warp sizing conference, held in May, 1934, to organize and finance a study of that subject, your Directors and your Research Council, at their meeting a year ago, were disappointed at the outlook for the latter, and with the comparatively slow progress that was being made in selling the organization to the industry. A few members and your Secretary, however, were confident that the warp sizing project would be financed, and that the results of this study would influence a needed increase in membership.

We recognize that the selling of this research organization to the industry will be a permanent job, but when we met Feb. 15 we found that our fears regarding the financing of the warp sizing project had been unwarranted. This job had been delegated to the Secretary, and it was so nearly completed at that time that we went ahead with plans for administration of the project, the selection of the place for its conduct, and authorized the Research Council to complete organization plans. It is hardly necessary to state that the co-operative financing of the project would have been rendered much more

difficult had not the Textile Foundation, by letter of Dec. 11, offered to match dollar for dollar up to $5,000 any monies that we might raise for this study. Without attempting to influence the policy of Textile Foundation directors, but because of our understanding that this is the first appropriation made by them on this co-operative basis, it may be noted that if this method of financing researches of this character could be adopted, it would double the funds thus made available by the Foundation.

The Division of Industrial Co-operation and Research of Massachusetts Institute of Technology was selected for the research, and an Administration Committee consisting of Wright Bolton of the Pacific Mills, chairman, Dr. J. B. Quig of Du Pont Rayon Co., and Dr. H. A. Neville of Lehigh University, was given full charge of the project. Its report, to be presented at this meeting, and that of the Secretary, both of which have been accepted by your Directors, contain additional details of the project that need not be repeated here.

It was provided by the meeting Feb. 15 that "the funds collected for the warp sizing study shall be carried by the Treasurer in an account apart from the Institute's regular funds, and that the Treasurer shall have full power to act in the disbursement of the warp sizing funds, excepting as already or in the future directed by vote of the Executive Committee."

On behalf of the corporation your Directors desire to formally record their obligation and thanks to those mills, firms and individuals who co-operated in the financing of the warp sizing project, and also to those who have since taken out contributing memberships for the specific purpose of receiving its confidential progress reports. Both are co-operators in this project and are as follows, the original financers leading the list:

Amoskeag Manufacturing Co., Arnold, Hoffman & Co., Aspinook Co., Atlantic Refining Co., Chemical Foundation, Inc., Cheney Brothers, Chicopee Manufacturing Corp., Cluett, Peabody & Co., Corn Products Refining Co., Du Pont Rayon Co., Erwin Cotton Mills Co., Exeter Manufacturing Co., Foxboro Co., E. F. Houghton & Co., Kali Manufacturing Co., Keever Starch Co., National Oil Products Co., Pacific Mills, Rossie Velvet Co., A. E. Staley Manufacturing Co., Standard Chemical Products, Inc., Stein, Hall & Co., Stonecutter Mills Co., Tennessee Eastman Corp., Warwick Mills.

American Bemberg Corp., Atlantic Gelatin Co., Berkshire Fine Spinning Associates, Bigelow-Sanford Carpet Co., Victor G. Bloede Co., Bloomsburg Silk Mill, Drake Corp., Fairforest Finishing Co., Farr Alpaca Co., Hart Products Corp., Milligan & Higgins Corp., Monsanto Chemical Co., Morningstar, Nicol, Inc., National Adhesives Corp., Penick & Ford, Ltd., Texas Co., United Chemical & Organic Products Co., North American Rayon Corp., Tubize Chatillon Corp., Waypoyset Mfg. Co., Paul Whitin Manufacturing Co.

Your Directors also desire to express their keen appreciation of the freely donated services of all who are so kindly co-operating in the warp sizing project, particularly the members of the Administration Committee, the Advisory Committee, Prof. Schwarz, who acts as contact man for the study at M. I. T., the mills which have granted us certain of their personnel, machinery and stock, and the firms which have donated supplies for the study. Such generous co-operation has greatly exceeded our anticipations, and confirms our belief that, given a worth-while research subject, the co-operation of a considerable cross-section of the industry can be depended upon.

While the annual report of the Research Council may duplicate in part what we have to report regarding our actions in its connection, we regard

them as of such vital import to the future of U. S. Institute that they will be noted in some detail. First, the Research Council, which was formed in 1933 with a membership from the Research Committee of members who were willing to give freely of their time, will, by vote of Sept. 27, succeed the old "Research Committee" and all of its sub-committees excepting the following: Committee on Economic Research, Warp Sizing Administration Committee and the Committee on Abstracts and Bibliography. The purpose of this action is the same as that which in 1934 transferred to the Research Council the real work of the old committee. The sub-committees now deleted involve no actual loss for they had long been inactive. New sub-committees will be formed as their need arises.

Second, and as noted in the call for this meeting, we feel that the time has come to give greater official recognition to the scientists and technicians who have been, and who must be in the future, the backbone of our services to the industry. Frankly, it must be admitted that heretofore directorships and offices have gone principally to mill executives, and with the possible object of impressing non-members with their prominent identification with the Institute. The executives and men in managerial positions will always be needed on the Board as they are in mill organizations, but the demand for more scientists and technicians as Directors and officers comes most insistently from this class of Directors, and because they recognize that this is essentially a research organization, and, therefore, needs the active services as Directors and officers of research men. This is the genesis of the following actions at the Sept. 27 meeting of the Board:

"Voted: That the present research committee and its subcommittees be replaced by a new body to be known as the 'Research Council,' to consist of the present members of the Council, and that the Council be empowered to create research committees and to add to its membership as occasion warrants.

"Voted: That the Research Council be empowered to initiate or co-operate in the solution of such problems as may be conducted without expense to the Institute, advising the Executive Committee of such actions. Work requiring the expenditure of Institute funds can be undertaken only after approval of the Executive Committee.

"Because of the increasing activities and importance of U. S. Institute's Research Council, and, therefore, of the responsibilities of the Chairman of that body, it was unanimously agreed by the meeting that the by-laws ought to be amended to make the Research Council a permanent body, with representation of its Chairman on the Board and the Executive Committee. It was, therefore,

"Voted: That the following proposed amendments to the by-laws be presented in writing to the Secretary, and that the Secretary, in a notice of the next annual meeting, include to each member a copy of the proposed amendments to be acted upon by the members at that meeting (see meeting program)."

Secretary's Annual Report

BEFORE entering upon the formal part of my report I desire personally, and on behalf of the other members of the Corporation, to record our deep obligation to those officers, directors and committee members who have given us during the year under review so freely of their ability and time. I desire again to thank our President, and his representative, Mr. William W.

Buffum, for their valuable advice and co-operation. I wish those directors and members who aided me in membership work, and particularly in our successful efforts to finance the warp sizing research, to know how much their help is appreciated. As managing editor of our magazine I want you to know also how much we are indebted to Prof. Schwarz and Mr. Weiss for contributions to the abstract section.

The financing and organization of the warp sizing research, that has been in progress since last May at Massachusetts Institute of Technology, will be accepted generally as our most important accomplishment during the year under review. Not only is it the first research financed under the auspices of U. S. Institute, but it is the first textile research to have been financed co-operatively, and its organization and administration plans are new and may prove worthy of being accepted as standards for further researches. It has demonstrated that the research-minded men, at least, of the textile industry can be depended upon to co-operate.

Whether U. S. Institute could have financed this two-year $10,000 project without the financial aid so generously given by the Textile Foundation is a question. When on Dec. 11 last we received the Foundation's offer to match our financing dollar for dollar up to $5,000, we had only $1,600 promised. We had matched their $5,000 early in March, and since then 21 contributing members have come in for the specified purpose of receiving the confidential progress reports of the warp sizing study, and they are still coming. However, it is useless to indulge in speculation as to what might have happened if the Foundation had not found this project worthy of their financial aid. The reports of your Directors and of the Warp Sizing Administration Committee will inform you as to other interesting matters regarding this project. Excepting for a brief period last summer, when I was asked to act for the Administration Committee, my activities in this connection have been confined to the raising of initial funds, and work on reports, questionnaires, conferences, etc.

Memberships

The fact that we are now actually engaged in research, and that only contributing members qualify to receive the confidential progress reports of researches, have been a big aid in securing this class of memberships, but have caused a decrease in annual memberships that will be referred to later.

Your Secretary has been greatly aided in membership work also by the action of the Directors at their meeting Feb. 15, in authorizing funds for traveling expenses on membership work. A total of $298.71 was thus expended, resulting in six contributing and two annual members. While this personal work will be continued the majority of new members has been the result of correspondence and of personal co-operation given me by members and others, among them Dr. Katz, Prof. Schwarz, Dr. Smith and Mr. Hayes. Especial credit goes to Pacific Mills, the Aspinook Co. and Erwin Cotton Mills Co., which in addition to a Life membership in the case of the first named, and contributing memberships in that of the other two, became also financers of the warp sizing research for two years.

Our membership as of Sept. 30 of the last two years was as follows:

	Sept. 30, 1934	Sept. 30, 1935
Life	2	2
Contributing	28	70
Annual	209	208
	239	280

Since the close of the 1933–34 fiscal year we have lost 39 annual members, of which 31 failed to renew and 8 were transferred to the contributing class. New annual members number 36, making a total of 208. Within the same period two contributing members were lost by transfer to the annual class and 44 new contributing members have been added. This total of 70 compares with a largest previous total of 35 (Nov. 1931). Of the present total, however, only the income from 45 is available for regular expenses, that from the other 25 being credited to the warp sizing fund.

The personal membership work that I previously referred to included a southern trip during the month of April that enabled me to contact some 60 mills and firms in the Carolinas and Georgia. A feature of this trip was the meeting of southern members that was held at the Poinsett Hotel in Greenville, S. C., April 11. There was an attendance of 47 members and guests, and our Greenville director, Mr. John W. Arrington, not only presided at the meeting, but was of great assistance to me in arranging for the meeting and the attendance of leading non-member manufacturers as guests. I was also deeply indebted to Dr. Smith who went to the expense of coming over from Kingsport, Tenn., to help out with the speaking program. Members present at this meeting were asked whether they favored the organization of a southern section of U. S. Institute, and their answer, and that of most of those I later contacted, was that it was not desirable at the present time. All of them, however, agreed that, when a research conference was to be held on some subject of important interest to southern manufacturers, it would be well to hold a session at some convenient southern city.

In authorizing the granting of contributing memberships to those cooperating in the financing of researches on the basis of $100 a year, and also in granting to contributing members the privilege of receiving confidential reports of all U. S. Institute researches in progress during the period of such membership, your directors have so greatly increased the potential value of contributing memberships that they should prove much more attractive than heretofore. In addition, each contributing member is privileged to have any five representatives receive our monthly magazine, *Textile Research*. Your Secretary credits these additional services to contributing members with materially aiding increase in this class of membership, but also as the cause of a considerable decrease in annual memberships. I refer to those annual members who cancel because they are able to secure the magazine on the contributing membership of their company. In such cases the Institute loses their services as members, and they lose all other Institute services. I shall not attempt to suggest what might be done to correct this situation. I will merely draw attention to the fact that if those non-members who have indicated interest in our research work by receiving our magazine could in some manner be added to our membership, the total as of Sept. 30 last would have been 494. If all contributing members took full advantage of having their representatives receive the magazine this figure would be well in excess of 500. I draw attention to this figure, because I feel that it is a more accurate yardstick of textile interest in research, and of U. S. Institute influence as a promoter of research, than our official membership, as of Sept. 30, of 280.

The Magazine, *Textile Research*

Our mailing list as of Sept. 30 was 587 copies, comparing with 412 copies on Sept. 30, 1934. The distribution compares as follows:

	Sept. 30, 1934	Sept. 30, 1935
To Members	237	275
On Contributing Memberships	72	185
Paid Subscriptions	52	69
Free List	51	58
	412	587

The increase in free copies on contributing memberships is due to the increase in that class of members and their more liberal use of the privilege of having any five of their representatives receive the magazine. As a result of the several increases noted the monthly printing has had to be increased from 500 to 700 copies, to provide an adequate reserve.

In the 12 issues of our last fiscal year we printed 580 text pages, of which 474 were devoted to research reports, editorials and miscellany, and 106 pages and 566 items to abstracts of textile research. Reports of Textile Foundation fellows occupied 359 pages, and 10 other research reports occupying 64 pages were also printed.

Magazine receipts aggregated $3,886.48, and the printer's bills for the 12 issues printed during the fiscal year totaled $3,866.13, leaving a debit balance of $20.35. The difference between the cost item noted and that reported by the Treasurer is due to the fact that the bill for the September, 1934, issue was not paid until October, his item of $4,202.66 covering 13 issues, instead of the 12 issues published annually. I desire again, in this connection, to emphasize the fact that no separate account is set up for the magazine. It is a service that U. S. Institute has obligated itself to provide for members, and non-members receive it at a purely arbitrary subscription price of $5.00 for this country and $5.50 for foreign countries. Were there to be added to the printer's bills (which cover paper, postage and several other items in addition to printing and mailing) the actual expense incurred by your Secretary's office for editing, proof-reading, correspondence, etc., it would be found that the actual cost of production is nearly double that reported, and requiring a $10 subscription price to cover the cost. As a research publication and promotional service U. S. Institute can afford to publish it as at present without advertising, provided the arrangement with the Textile Foundation is continued by which we publish the reports of their Fellows at an arbitrarily determined cost price per page. The Foundation, by the way, has kindly renewed this arrangement to cover Vol. VI of the magazine.

Your Board of Editors, Publication Committee and Managing Editor desire to thank those who have kindly co-operated in furnishing original research and other material for publication, and to express the hope that they may have more general co-operation, and also suggestions for the improvement of *Textile Research*

The Book, Textile Research: A Survey of Progress

Through cash sales and by the use of our book, "Textile Research: A Survey of Progress," as a premium to new members and to new magazine subscribers we have distributed an additional 69 copies during the year. Of an original printing of 2,574 copies we have distributed 1,782 copies and have on hand 792 copies. Gross receipts to the end of the fiscal year were $2,233.05. We continue to receive inquiries as to whether another up-to-date edition is to be published.

Necrology

While we have lost no members by death, we regret to record the passing of two representatives of Contributing memberships: Mr. A. L. Lustig, representative of the original contributing membership of the Apponaug Company, of which he was president. Mr. Lustig had been a director and vice-president of U. S. Institute and a faithful and active member. His death occurred Mar. 19.

Mr. James Thomson, representative of the Contributing membership of Minot, Hooper & Co., died Oct. 3. He started and closed his business career with this dry goods commission house. He had also held the following positions: Dwight Manufacturing Company, assistant treasurer; Arnold Print Works, treasurer; Harmony Mills, agent; Fairhaven Mills, treasurer; and at the date of his decease he was assistant treasurer of Dwight Manufacturing Co., and general manager of Minot, Hooper & Co.

Report of the Research Council

By WARREN E. EMLEY, Chairman

THE work of Mr. Bolton's committee on Warp Sizing, and Mr. Blanchard's committee on Economic Research, has progressed rapidly during the year and will be the subject of separate reports presented at this meeting.

At the suggestion of the Throwsters Research Institute, a conference on the crêping of rayon will be held this afternoon. The information developed at this conference will, it is believed, be of value to the Throwsters Research Institute in helping them plan their research work on the problem. It should also open other fields of investigation which can profitably be undertaken by other groups.

Negotiations are under way with Lowell (Mass.) Textile Institute for the preparation of a handbook of test methods and standards for those things which the textile mills buy. To a large extent this handbook will be a compilation of information which has been developed by the American Association of Textile Chemists and Colorists, and the American Society for Testing Materials, put into compact form, readily useable by mill men.

The National Bureau of Standards has undertaken to develop a simple mechanical device for the matching of dyeings as a matter of mill control. The Massachusetts Institute of Technology is considering the possibility of developing a similar device for the mill control of the finishing process.

The American Society for Testing Materials has undertaken a comprehensive study of the regain of textiles and the effect of moisture on the physical properties of fabrics.

Both in the conducting of work for which funds have been specifically provided, and in the initiation and encouragement of work done by others, the Research Council believes that satisfactory progress has been made during the year just closed.

Report of Committee on Economic Research

By F. S. BLANCHARD, Chairman

I SUBMIT herewith a report of the activities of the Committee on Economic Research for the year 1935.

The function of this Committee, as we conceive it, is to stimulate and aid research in the textile industry in the economic and distribution fields and to attempt to guide this research along sound lines. Our Committee, we hope, fairly represents in its membership the different branches of the textile industry and it is from the point of view of the industry as a whole that we attempt to carry out the above function.

In 1935 our principal activities have been as follows:

(1) Aid to the Department of Commerce in connection with a WPA project on distribution research, to be undertaken as a relief measure for so-called white collar workers. This project was first brought to our attention by Mr. Pickard, Chief of the Textile Section of the Department of Commerce, and the advice of our Committee has been made available through him and also directly to Dr. Wilford L. White, Chief of the Marketing Research and Service Division of the Department of Commerce. Our Committee held several conferences with Mr. Pickard and Dr. White and has offered a number of suggestions in connection with the proposed project, which has to do with a survey of distribution costs in the textile industry.

A number of written suggestions in connection with this study have been sent to Dr. White, in addition to the points brought out at our conferences and, particularly, our Committee has urged the importance of a study of the distribution costs of specific textile products rather than attempting to undertake general studies which will be of little practical value. Our Committee has held conferences with the heads of some of the leading textile associations and men interested in distribution research in the industry and has found that the unanimous opinion of these men agrees with that of our Committee. For example, it is felt that it would be far better to take a yard of print cloth sold over the counter, or a worsted flannel robe, or a pair of overalls and work out the elements going into the consumer cost for that article, working back through the distribution costs of each step, rather than to attempt to report the average distribution costs of a wide, somewhat unrelated group of products. Such a study, by a proper breakdown of the principal cost elements in each stage of distribution, would throw considerable light on our whole distributive system and might bring about a better understanding of the possibilities of more efficient and less costly distribution.

This view of the Committee is now under consideration by the Department of Commerce and our Committee is awaiting further word from Dr. White as to the final decision on the exact nature of this project so far as the textile industry is concerned. Dr. White has expressed his desire to co-operate with our Committee as far as possible and to work out something which the industry feels would be of practical value, and which at the same time can be successfully undertaken by the WPA men who are likely to be available.

It is interesting to note that this problem of the gap in price between that charged by the mill for a textile product and what the consumer ultimately pays is also being given thorough consideration by two other branches of the Government—one by the Review Division of the NRA, to be used in connection with their factual report to the President regarding NRA experience, to serve as a possible basis for new legislation. At the same time Dr. W. H.

Hamilton, the President's advisor on consumer problems, we understand is having his research staff study the possibilities for reducing the spread between cost at the factory and the price paid by the consumer.

(2) Our Committee on Nov. 1 proposed for the consideration of the Textile Foundation a study of the possibilities of vertical integration in the textile industry, with particular reference to the conditions under which such integration is likely to be successful and the conditions under which it is not likely to succeed. Such a project would involve case studies, not only of the experience of companies in all the different branches of the textile industry, but also of experience in other industries where conditions are sufficiently similar to throw some light on the textile situation. It would involve studies of cost and price advantages and disadvantages of different forms of integration, of organization and administration problems to be met; to try to answer the question of why some attempts have succeeded and why others have failed.

In connection with this recommendation which we have laid before the Textile Foundation, our Committee has been in touch with the presidents of the principal textile associations and has found a great deal of interest in such a study. This matter is now in the hands of the Textile Foundation for their consideration and our Committee stands ready to advise and assist in any way possible those whom the Foundation may choose to undertake this research, provided, of course, that the undertaking is approved.

It seems to the Committee that this particular study, which will concern itself with organization and marketing problems, as well as with costs, would supplement rather than duplicate the other work on costs referred to above. Our Committee has attempted to keep in touch with the different projects being undertaken or under consideration in this broad field, so as to avoid recommending any studies which are already in prospect or under way and in order to have these studies tie in with and supplement each other. We would welcome suggestions from any member of the Institute or interested member of the industry on any of the above matters.

Report on Warp Sizing Study

By WRIGHT BOLTON, Chairman Administration Committee

THERE is very little to report regarding the warp sizing research that has not already been covered in the reports of the Board of Directors and of your Secretary, or that has been given in the first confidential progress report to co-operators, and that will be contained in the second report that will be ready shortly. I might report, however, that a new laboratory has been fitted up at M. I. T. especially for this study that should help facilitate the work.

I have been greatly impressed by one unexpected result of this research. I refer to the awakening of the industry generally to the importance of warp sizing, and to the fact that it is not the simple process that so many mill executives thought it to be. Now that we have shown it to be one of the most complicated of research problems a general effort is being made to improve this process. The manufacturers of sizing materials and of machinery used in sizing are showing great interest in our work and are engaged themselves in new development work. I like to think this is all a direct result of our warp sizing study. It is indicated from what has already been accomplished in this study that we are going to get some interesting and illuminating information on sizing materials. I am very optimistic as to the results that we shall obtain in this study.

Conference on Rayon Crêping Problems

THE open conference on rayon crêping problems was the third of this type of conference (the first of which was held by U. S. Institute in 1933) for the purpose of learning through open discussion by authorities whether a problem required scientific research for its solution. The first discussed problems associated with the wear of textiles and wear testing, and the subject has been temporarily dropped. The second, held in May, 1934, resulted in the current warp sizing study. Warp sizing is a source of rayon crêping problems, as is the soaking process which has been selected by the Throwsters Research Institute for study in conjunction with the research committee of the American Association of Textile Chemists and Colorists. This conference, therefore, was held with the co-operation of the Throwsters Institute, and it has also received the co-operation of the National Rayon Weavers Association. Based upon attendance at former conferences, it was thought that this one might require a room seating 150 to 175 people, but to accommodate the crowd of more than 225 it was necessary to adjourn to the Astor Gallery, where the discussion lasted until 5 P. M. The following committee had charge of the arrangements for the conference: Dr. H. DeW. Smith, chairman, H. E. Bishop, B. L. Hathorne and C. H. Clark.

Dr. W. E. Emley, chairman of the Institute's Research Council, was to have presided at the conference, but a tour of military service prevented, and Dr. H. DeW. Smith, vice-chairman of the Council, served in this capacity. His introductory remarks and his summing up of the discussion, together with Mr. Bishop's remarks in opening the discussion will be found among the papers and addresses in this issue. The stenotype report of the discussion has been referred to the committee in charge of the conference for editing and will be published in the January number of the Institute's magazine. If the editing is completed sufficiently in advance of that publication date it will be mailed in mimeograph form to those who have registered to receive it.

Opening Remarks of Chairman Smith

THIS meeting has been called by the United States Institute for Textile Research with the active co-operation of the Throwsters Research Institute. Dr. Warren E. Emley, the Chairman of the Research Council of the Institute, who was to have presided today, has been detained in Washington by an unexpected two weeks' tour of duty with the reserve corps. I don't think that means war with Italy or anything like that, but Dr. Emley spends two weeks every fall in the Procurement Division of the War Department, and carefully arranged to have this start on the tenth, when our meeting was scheduled for the seventh of November. I saw him in Washington on Tuesday, and he said the "red tape" involved in getting

one of those tours of duties transferred at the last moment was too great to undertake. Therefore, unfortunately, he could not get here, and he has asked me to act for him.

The subject of today's Conference is, "Rayon Crêpes and Rayon Crêping Problems." Its purpose is to provide for an exchange of views on the various problems connected with the manufacture of crêpe fabric from rayon yarns, with the object of obtaining such a broad and thorough conception of the nature and the extent of these problems that a comprehensive and a practical plan of co-operative research can be worked out, if it is found advisable.

The discussion today will be opened by Mr. H. E. Bishop, the Executive Secretary of the Throwsters Research Institute, who has consented to provide the spark to set off the ideas and the questions with which we hope your minds are charged this afternoon.

As you all undoubtedly know, the Textile Foundation granted a fund recently to the American Association of Textile Chemists and Colorists through the good work of Professor Olney, the Chairman of the Research Committee of that Association, and the A. A. T. C. C. in turn has enlisted the co-operation of the Throwsters Research Institute to carry out some research work on throwing. The Throwsters Institute has raised from its own organization and from others interested in the problem an equal sum for this work. Mr. Bishop will discuss the plans to date of this project, and we hope that today's meeting will be helpful to this work by providing a survey of the whole subject of crêpes and crêping, and that it may also give us a picture of the whole broad problem.

There will be no other formal speakers this afternoon. The meeting will be immediately thrown open to informal discussion from the floor, and we hope that you will all contribute freely of your ideas, and your problems and your questions.

We are seeking all possible information. We come here as listeners today. We want information on the troubles encountered in connection with the production of rayon crêpes and the known or the suspected causes of these troubles, and on the remedies that have been tried or that have been proposed.

In order to cover all of the ground, we have planned to take up the subjects to be discussed in chronological order, and we shall try to distribute the time allowed so that each phase of the subject will receive due consideration. This will require approximately a half hour's limit on each of the six subjects that we have tentatively set and we will have to try to be flexible, if one seems of much more importance than some of the others.

In order to give everyone a chance for expression today, I am going to ask you to make your remarks as brief and as pointed as your meaning will permit, but I am also going to ask you to be sure to make some remarks, please.

The subjects, as we have divided them, are as follows:

The Soaking Operation, and Oils and Mixtures Used in This Connection.

Twisting.

Steaming or Setting.

Copping.

Weaving.

Finishing, including the factors which affect pebble, hand, and other qualities of the finished fabric.

Introduction to Discussion

By H. E. Bishop

WE want to sound a note of extreme informality this afternoon so that everybody will feel entirely free to get up and say anything that is on his mind. I am a little bit embarrassed this afternoon. I asked several of my friends what I should say and they wouldn't tell me, but it may have worked out all right, because when I expressed that to another man and said that nobody told me what to say, there seemed to be a broad smile, so I guess it is all right.

Picking this up from where Dr. Smith left off, I think it might be well for me to tell you what happened to us Tuesday evening. When we got the grant through the kind auspices of the A. A. T. C. C., we were faced with the necessity of doubling the amount from the industry. At that particular time, the Throwsters were just in the throes of overcoming the collapse of NRA and our Board voted to table the matter.

Fortunately, it worked out in this way: that prior to the A. A. T. C. C. and the Textile Foundation tabling the matter, the thing was granted and it came back to us, so we feel, the original steps having been taken, that we should try to work out a co-operative research.

In other words, we did not feel, as an Association, that we could spend the money that was necessary. We felt it was a problem for the whole industry to deal with, so we approached some of the rayon yarn people and rayon weavers of the industry and received co-operation from them.

So, regardless of the Press release in this morning's *Daily News Record*, which said this is a Throwsters' problem and a Throwsters' proposition, I can assure you on behalf of the officers of the Institute that we issued that publicity in a different form. In the form in which it was given to the Press, we pointed out that we had received the assistance from the various branches of our industry.

Therefore, I want that cleared right here and now, so that you will know that we appreciate the co-operation of all branches of the industry who have gone along with technical assistance and financial aid.

I further wish to thank very much the U. S. Institute for giving us this opportunity for free and open discussion of these problems that we are confronted with.

On Tuesday evening we had an organization meeting of a committee to direct the research. At that meeting we tried to get down to facts, methods of operation, and what we had to study, and so forth; and in the interest of brevity I am going to read you the first page of the schedule that was presented at that meeting.

Objects of Research

(1) To establish as facts the relative importance of variables affecting pebble of finished fabric.

> Example: Determine relative importance of variations within the rayon, variations in humidity, etc. To what extent can these be "covered" by processing, by sizing methods, by embossing, etc.

(2) To determine and establish as facts the effect of small increments of change in each controllable variation.

Example: (*a*) Effect of varying percentage of sulphonated oil and raw oil in the oil constituent of the size bath.

(*b*) Effect of increasing humidity of throwing room (30%, 40%, 50%, etc.).

(3) To determine the degree of uniformity of result that may be expected from existing rayons and mechanical appliances.

(4) To present the facts established in such a manner that they may be utilized in two different ways:

(*a*) To reduce claims. Manufacturers should not be held responsible for variations in finished fabric that fall within the normal variations that must be expected from existing processes and equipment, even though special constructions (such as oatmeal cloth) tend to cause or allow such variations to manifest themselves as visible variations in finished fabric.

(*b*) To enable individual manufacturers to better understand certain of the manufacturing problems with which they are constantly faced.

To digress for a moment, I will say that the final committee that is appointed (that is, the permanent committee that is appointed for this research matter) is subject to change, if any of you gentlemen have suggestions to make in that regard. We do not want too large a committee, but at the same time it can be added to. The permanent committee is as follows: H. E. Bishop, Throwsters Research Institute; Charles M. Epstein, Liberty Throwing Company; E. C. Geier, Duplan Silk Corporation; B. L. Hathorne, Berkeley Products; Joseph B. Quig, Dupont Rayon Co.; Irving J. Saxl, Waypoyset Manufacturing Co.; H. DeWitt Smith, A. M. Tenney Associates; V. McCullum, National Silk Dyeing Co.; Gordon C. Young, Burlington Mills.

That committee has taken under advisement the brief that was submitted at this meeting on Tuesday, and is going to sit in at a meeting on December 3 for a final decision as to what we are going to do.

At the meeting on Tuesday, the proposed detailed technicians' research program had the following factors requiring study: We are dealing with a new fibre. There is not too much known about it. The trade is in a tremendous amount of difficulty. We are getting claims on the Throwster, claims on the yarn producer, claims on the weaver, claims on the dyer and finisher, and it is a very grievous situation. Some of that is due to a dropping market, unquestionably, but regardless of that fact we should know where we stand as rapidly as possible.

The items requiring study that were brought up were: (*a*) Effect of variations found in normal first-quality rayon; (*b*) Effect of soaking bath variations; (*c*) Effect of extraction; (*d*) Effect of drying; (*e*) Effect of winding; (*f*) Effect of throwing; (*g*) Effect of setting; (*h*) Effect of redrawing; (*i*) Effect of copping; (*j*) Effect of weaving; (*k*) Effect of warp size; (*l*) Effect of dyeing and finishing operations.

As a matter of interest, following the reading of this program there was considerable discussion as to just how far we should go in this research program, and there were two schools of thought. I am going to make no

recommendations at all myself. One was that we should take, for example, the sizing materials and make a complete and thorough investigation of gelatin, for instance. As a matter of fact, you can spend $100,000 and not know any too much about the various ingredients and methods of procedure in soaking. Of course, we do not have $100,000.

The other school of thought was that, instead of taking one particular thing, such as oil or gelatin, we would try to hit the high-spots by controlled conditions; not taking, for example, in soaking the static bath, or what not, but that we should take the standard conditions and proceed from that point and go ahead and use standard materials, to see if we can find in these various processes what particular process or processes are causing us the main difficulty, and proceed from that point further into the matter.

Both opinions were expressed quite freely, but the final speaker (I won't say whether he swayed the meeting or not, because I frankly can't know until we take our final vote on Dec. 3) pointed out the fact that we are faced with a practical condition; that we want to get as quick and valuable results as we can. That is exactly what has happened and the purpose of this meeting is to get into all these various points and get your viewpoints.

Summary of Conference Discussion

By Chairman H. DeW. Smith

THIS problem is similar to our warp sizing problem. There is not any doubt that there are a great many mills that are doing a very excellent warp sizing job and doing it very dependably. There also isn't any doubt that there are many mills that are not, and some of the best of us get into variations.

I am not certain about this, but it seems to me we can't expect our warp sizing research to revolutionize the art of sizing yarns. If it does, that will be news. But the most I would hope to get, and I would think the project very successful if we did, is to have made available to everybody a uniformly dependable system of sizing warp yarns properly.

That system may not be any better than some people have today, but it will enable the production of more uniform cloth. More mills, and the mills who are making the good products today, will certainly have benefited by the work, in that factors that they themselves have not worked out will be illuminated to them by this work. I feel that any crêpe throwing problem must do the same thing.

It is perfectly evident that the problem is tremendously complex, more complex than warp sizing by far, because in the course of the afternoon, from the very few notes that I have recorded, we have decided, or rather it has been expressed, that the gelatin performs several functions. It increases the strength and it helps to set the potential energy in the yarn. We have learned that the characteristics of the individual yarn vary one from the other, and that it is necessary to understand the behavior of each individual brand of yarn if a throwster is to deliver each brand of yarn so as to give the crêpe desired.

That alone means that an individual throwster must perform a great number of experiments to understand completely each of the brands that are on the market. He probably has the most complete experience with one

or two brands that he throws the most, but he can't limit himself to one brand in most cases. He takes the business that he can get and wants to understand how to handle that particular product.

In warp sizing the mills have long ago learned that the various viscose yarns and the various acetate yarns require individual treatment, according to the subtle differences in their properties. The same is undoubtedly true of the yarn for filling purposes, and that is one thing that was brought out strongly today.

We have learned that the oil serves several functions. Undoubtedly, it acts as a wetting agent; undoubtedly, it acts as a lubricant, and undoubtedly it acts as a plasticizer to keep the gelatin film soft and adhesive at the same time.

The question of filament structure has not been discussed very much, but I think there is no doubt that there must be a difference in one brand of yarn, and one denier, if the filaments in one yarn are coarse and the filaments in the other yarn are fine, because in one case you have a series of very fine rods and in the other a series of very coarse rods, and the stresses that you set up with a different number of turns are certainly different in those two types of structure.

The question of tension has been brought up, and the fact that you can't exceed the yield point. It has been expressed here, on the one hand, that tension is not very important within the limits of tension which apply in manufacturing, and on the other hand that it is very important.

That is another controversial question, but it is certain that tensions can be exceeded, which will produce elongations in the yarn, and which will subsequently tend to contract, upon wetting, at a different rate, as compared to yarn that has not been subjected to those elongations.

The factor that we have not even mentioned today, but which I am sure is uppermost in all of your minds, is the effect of humidity in the room after the yarn is thrown and set. Setting is a subject we have not discussed, and the effect of steaming on the yarn after you have gotten through your soaking and your throwing process.

It is certainly true that if we are storing up a potential energy in this yarn which we want to release at a later date by immersion in water, we must be able to control the amount of that potential energy to a great extent by the steaming treatment that we give it; so, there is another variable factor.

The effect of the warp size was only mentioned once, but we all do know that whether it be an acetate or viscose warp, there is a decided effect, not only because of the rate at which the warp size leaves the warp yarn in a condition to be contracted, but also, as has been pointed out, by the relative coefficient of friction, or the binding power of that warp size, or of one warp compared to another, perhaps of exactly the same construction.

Then there is the factor of fabric construction, which means the tightness with which the interlacing is held, which must affect an absolutely uniform prepared yarn to a great extent in the finishing operation.

Then there are the loom adjustments. I think we are agreed that the tension under which the warp is held, and all of the adjustments on the loom, must be possible factors in producing an interlacing that will later affect the finish.

Then there are our good friends, the finishers, who are so often the

targets. Then it usually goes back along the line until it gets to the yarn manufacturer, and we all try to explain the same defect, or explain that it wasn't our fault after all. The finishing operations undoubtedly are of tremendous importance, and this price pressure, that is forcing finishing to be done more and more rapidly, is without a doubt a very direct influence on many of the claims that we have in the market.

The Throwsters Institute cannot hope to solve all of these problems with $5,000, nor can the U. S. Institute hope to solve them all with a good deal more money than that even, if it is able to raise more money. Some of the economic problems I frankly don't know how we can solve; but we have indicated how complex the problem is.

Now most of us knew how complex the problem was before we came here today, and I do not profess to say that we have unearthed a great deal of information. All of us had some of this; many of us had most of it; but I do feel that a gathering of this sort gives a chance for an interplay of opinions and ideas, and should stimulate each of us to further thought, and perhaps upset some of our own pet theories and make us think a little bit of what the other fellow said, that at first glance seems rather asinine to us. We have a great tendency to defend our own opinions and to think that our particular theory or solution of a problem is the only one; and perhaps one of the most useful functions that the Institute can perform is to bring each mind into contact with the opposing mind, so that you will go away and think some more about the apparently foolish theories that your opponent has expressed.

Thus, there are two things that we would like to get out of this Conference. The Research Council expects to study these notes and other information that it can get, and I am sure that the Throwsters Committee expects to do the same thing. (Any of you who wants a transcript of these notes can have it by applying to Secretary Clark.)

Most of us have our most brilliant thoughts after we get out of a meeting. I always do, and I can assure you that about an hour from now, I shall have a couple of swell ideas that I shall wish that I had expounded from the platform. But I shall be able to use them if I get to the meetings, which I expect to attend, and we would be very grateful to you if each of you would get equally brilliant thoughts to bring to us, to Mr. Clark, Mr. Emley, or myself, so that we will have every scrap of information that you can give us on this thing. Even if you think that we are all crazy, and you write and tell us so and why, it would help to steer us.

I can assure you that if we can just get hold of one little point today, such as Dr. Rose suggested, that is, to take one brand of yarn and treat it under a series of conditions which do not duplicate exactly anything that has been done before, we shall have been able to contribute something. If we can take the papers that have been published and sit down and try to correlate the information, we learn the rules of this game, which seem to be very complex.

The Annual Dinner and the Addresses and Papers

HERETOFORE at annual meetings there has been but one session, this combining the formal corporation meeting, luncheon and speaking program. This first attempt at a formal dinner, therefore, is a credit to the committee in charge, and to all who had a part in it. The menu was one of Oscar's best; the attendance of over 200 exceeded expectations; the speaking program was of the highest degree of excellence and interest, and it would have been over by 10:30 P. M. instead of 11 P. M., if the dinner had started promptly at 7 o'clock. The most valid criticism heard was that there was a plethora of good things.

President Francis P. Garvan, who acted as toastmaster for the speaking program in his usual effective and interesting manner, spoke but briefly prior to introducing the first speaker. He did, however, report that Secretary of Agriculture Wallace, in a recent address, had gone on record in favor of more research for agriculture, and stated that, if he meant what he said, there is $100,000,000 available for such research, and he advised the Institute to busy itself in preparing a program for Sec. Wallace.

President Garvan had with him at the head table as guests of the Institute Dr. Robert Andrews Millikan, chairman executive council California Institute of Technology and director Norman Bridge Laboratory of Physics; Dr. Karl T. Compton, president, Massachusetts Institute of Technology; Franklin W. Hobbs, chairman, Stuart W. Cramer, treasurer, and Frank D. Cheney, director, of the Textile Foundation; H. E. Bishop, executive secretary the Throwsters Research Institute; Dr. J. R. Katz, director of U. S. Institute's warp sizing research, and Wright Bolton, chairman of the warp sizing administration committee. Also at the head table were the following officers and directors of the Institute: Alban Eavenson, Ernest N. Hood, Dr. E. H. Killheffer, Prof. L. A. Olney, Dr. R. E. Rose, Prof. E. R. Schwarz and Dr. H. DeW. Smith.

The Institute also had as its guests at the dinner the following association officials and manufacturers: W. Ray Bell, president, Association of Cotton Textile Merchants; C. W. Dall, president, National Rayon Weavers Association; Peter Van Horn, president, National Federation of Textiles, Inc.; Edward T. Pickard, secretary, the Textile Foundation; Dr. Henry A. Barton, director, American Institute of Physics; Howard A. Poillon, president, Research Corporation; Wheeler McMillen, editor, *Country Home;* John W. Manley, president, Sayles Finishing Plants, Inc.; Leonard S. Little, president, U. S. Finishing Co.; Albert Bosshard, Stehli Silks Corp.; P. A. Vogelman, president, Onondaga Silk Co.; C. A. Mace and C. C. Concannon, Synthetic Organic Chemical Manufacturers Association; Sidney Townend, British Wool Industries Research Association; Donald Purrington and Theodore Richings, Wm. Skinner & Sons; Dr. D. S. Chamberlain, Warwick Chemical Co.; Dr. S. Lenher and Dr. Lubs, E. I. du Pont de Nemours & Co.

The Speaking Program

Following his brief preliminary remarks President Garvan introduced the guest speaker, Dr. Robert Andrews Millikan, the audience rising and greeting the distinguished guest with applause. Dr. Millikan was originally scheduled as the final speaker on the program, the change being made at his request to allow him to leave early; he remained, however, long enough to hear several of the reports of textile research application. Dr. Millikan's address, published complete in this issue, should have been heard to be fully enjoyed; and this notwithstanding the fact that he read it. In effect, however, it was an extemporaneous rendition. Dr. Millikan is too well known in the fields of science and industry to require a bibliographical sketch or a record of his great accomplishments here. However, those who would like to read of an intimate sketch of him can find it in the article by John Janney, in the December number of the *American Magazine*, under the title "Ten Men in One. Millikan—Supersalesman of Science." The correctness of the last part of that title finds ample demonstration in his address to the Institute, and the protracted applause of the whole audience, which arose at the close of his address to express their appreciation.

Symposium on Applied Research

President Garvan next called upon Prof. E. R. Schwarz to introduce the four men who were to present papers in the symposium on "Recent Practical Applications of Scientific Research in the Textile Industry." Prof. Schwarz demonstrated by his introductions that science is not the dry and uninteresting thing that it is so generally supposed to be, and also that the scientist still retains a sense of humor; one of these was the story of Sadie and Sam that Dr. Compton told at last year's luncheon-meeting, and that may be read by referring to the report of that meeting, but two of his introductions are recorded, as follows:

"In introducing the first speaker I might simply say 'all textile fibres are birefringent (polarizers of light), hence the logic of studying them with a polarizing microscope.' This statement probably conveys no idea of the actual facts, so that a very crude analogy may be pertinent. If you will imagine a milling crowd of people passing through turnstiles into a subway the matter may be clearer. It is obvious that the crowd will be moving in the same direction as each individual emerges, provided always that one essential condition is fulfilled: that each must emulate little Jimmy of the popular song and have a nickel. Apologizing in advance for a horrible play on words, each investigator examining fibres through the microscope must have not one but two Nicols—in this case specially constructed optical prisms, named for the designer. A study of the fundamental or pure science aspects of polarized light as applied to textiles has been under way for some years. The work to be described is only one practical application, 'The Cotton Classer Uses the Polarizing Microscope.'"

"To turn from popular song to the other great American amusement, the movies, we might note that not only in the case of Mae West, but also in rayon and now in silk, we are greatly interested in shape and size. That much of the work to be described was done in connection with hosiery is only appropriate. 'Silk Filaments' Shape and Size Cause Two-Tone Dyeing.'"

The papers presented by Messrs. Pattee, Kruegel and Mennerich, and Dr. Saxl, covered scientific research that, in most cases, had been actually applied in the textile mills with resultant substantial economies. Unfortunately, it was not possible, in the short time allotted, for the speakers to explain these applications in detail, but they either have been or will be thus explained in this magazine. A detailed report of Mr. Kruegel's work to date as a Fellow of the Textile Foundation will be found in this issue. The papers presented in this symposium were as follows:

"The Cotton Classer Uses the Polarizing Microscope," by Chesler L. Pattee, technician, Pequot Mills, Salem, Mass.

"Scientific Wool Top Standardization to Meet Commercial Conditions," by E. O. Kruegel, Fellow of the Textile Foundation working at Massachusetts Institute of Technology.

"Silk Filaments' Shape and Size Cause Two-Tone Dyeing," by F. A. Mennerich, microscopist, United States Testing Co., Inc., Hoboken, N. J.

"The Physicist in the Textile Industry," by Dr. I. J. Saxl, director, research and development, Waypoyset Mfg. Co., Pawtucket, R. I.

The hour was so late when President Garvan introduced Dr. J. R. Katz, director of the Institute's warp sizing research, that he spoke much more briefly than he had intended to, and as was hoped for by the audience, the majority of whom had waited especially to hear him. His address, and the addresses and papers of the other speakers will be found in sequential order in this issue.

The reception committee for the dinner was as follows: Alban Eavenson, chairman, D. E. Douty, Ernest N. Hood, P. A. Johnson, and A. M. Tenney.

Opening Address of President Garvan

I BID you welcome to this annual event of ours and I can ease you by promising that you are not going to suffer from any speech from me tonight. We have so many brilliant speakers here, particularly our guest of honor, who has traveled all the way from California to be with us tonight, that I feel under these circumstances a good deal like Pres. Dwight of Yale. I went to him one time to intercede for a student in New Haven and I asked him whether he was going to the Yale–Harvard game which was going to take place the next Saturday in New Haven. "No, I am not, but it is very hard for me to determine exactly the reason why I am not going to attend," he said. "I think that possibly my presence would so far encourage the Yale team as to give them an unfair advantage. Or it would so far discourage the Harvard team that it would give them a disadvantage." So tonight I am torn through these different motives and am not making my usual brilliant speech.

I just want to say one thing. The dawn of intelligence took place sometime this afternoon, I think in this hotel. Mr. Wallace, the Secretary of Agriculture, made this statement: "American agriculture with or without Federal guidance must adjust itself to a radically changed market situation, the outstanding feature of which is a lessened opportunity to export. American farmers must cease to produce for a market that has disappeared, and, unless adjustments are made in the tariff structure, must adjust their output to a market that exists or can be created. This necessity applies equally to the food producers; neither processors, nor products,

nor farmers can make money working for a vanished market. As we move from emergency to permanent adjustment and correct the shortcomings that developed inevitably in the experimental stage we shall draw more heavily than ever upon research."

Now Mr. Wallace, if he means those words, can make good. Section 33 of the AAA amendments to the last bill gave Mr. Wallace 30% of the tariff duties during this year to be spent to solve the problems of farm production. That paragraph is cut as wide as possible, and wide enough to pay for any research which you gentlemen may request which will increase the consumption of the farm products of cotton, wool, etc. So I think it is the duty of our committees to get together and lay out as many projects of researches as you can imagine for the best interests of the industry, and take them down to Mr. Wallace. That sum amounts to $100,000,000 this year, and if he sincerely wants to help the producing agriculturist the way to do it is to give him the research which will enable him, not only to hold his own markets, but to go out into the markets of the world and fight for them. He cannot object on the ground that we must have imports to pay for exports, because we had an unfavorable balance of trade of $900,000,000 last year, that next year will amount to a billion and a half dollars. There is invested in foreign capital in this country now between six and seven billion dollars, or was the first of last January; that has now been increased by an average profit of 40%, and so the foreigner has the profit right here to pay for any exports which the world may want from your industry or from anyone else's industry. Therefore, all impediments have now been removed and it is only up to us to do the researching out to produce the products to meet the world demand.

We have with us tonight Dr. Robert Andrews Millikan, chairman of the executive council of California Institute of Technology and director of Norman Bridge Laboratory of Physics, but any introduction from me to you, gentlemen, is unnecessary. Dr. Millikan is perhaps the leading scientist in the world today, and it would be foolish and silly for me to attempt to limit a description of him to my poor vocabulary or imagination. I want to thank him on behalf of everyone of you for the sacrifice of his time in coming all the way from California.

Whither Scientific Research in Industry?

By DR. ROBERT A. MILLIKAN

IT would be the height of presumption for me to attempt to address you about any of the problems of your industry for I have had no experience with them and know, at first hand, nothing about them. That might be thought by some to qualify me admirably for a high political post, but surely not for an industrial one, and I am only too well aware that I am talking, not to the mass mind, but to a group of experienced and competent industrialists. My only qualification for associating with the textile industry is found in the clothes which I wear. The fabric is the product of the Pittsfield mills of a distant cousin of mine who knows how to make good cloth, so I may possibly have a little good textile germ-plasm tucked away somewhere in my system.

Mr. Garvan, who is responsible for thus bringing an imposter before

you, has perhaps felt that the "stripped atoms" and other naked truths with which I have spent my life needed contact with some kind of a reputable clothing establishment. Anyway, what I propose to talk about for a few minutes is where our science is leading us industrially, and what if anything we ought to be doing about it. It has had heavy charges made in some quarters against it. Out in the western part of the country from which I have just come, I was told of two very recent happenings which suggest research in other fields than science into their causes. A certain company which had some excavating to do was asked not to do it with its steam shovels but rather to let men who needed work do it by hand. The same company in order to start up new work advertised for five hundred new employees and after two weeks of waiting had received eighty-one applicants, though there are thousands upon thousands in the State on the relief rolls. Does this suggest that science is the cause of *all* our unemployment as so many voices are shouting now-a-days?

What then has actually been the effect of science upon the life of modern man? Can we find a definite answer to that query? In part at least we can. That is the first question to which I wish to devote some attention.

The supreme contribution of science is not in terms of industrial results, though these have probably been indirect consequences. The key to modern civilization, and perhaps the most significant step ever made in human progress, is to be found in the beginning, about three hundred years ago, of the series of experiments and discoveries which have led and are now leading very slowly but appreciably to the substitution of the scientific, rational approach to life for the wholly emotional, superstitious approach that was characteristic of all earlier civilizations and still, alas, is characteristic of the attitudes of great masses of our population.

But just what do I mean by the rational, scientific attitude. It has two elements. One is the faith (which during the past three hundred years has been changing into the firm conviction, in many minds) that this universe of ours, from electron up to stellar galaxy, is fundamentally an orderly and dependable affair instead of a capricious one, and therefore, that it is worthy of study because capable of being known. The second element is the conviction that man has the capacity, through sufficient observation and study, of actually acquiring definite knowledge about that order—to some extent at least *comprehending* that order—and then directing his own life in accordance with that comprehension; in other words, to a certain extent, controlling his own destiny. The emotional, superstitious attitude is necessarily fatalistic, as were, in fact, all ancient civilizations. The scientific, rational attitude is optimistic because it makes man himself for the first time a vital agent in the march of things. The first attitude results in autocratic government, blind submission to the higher powers, divine or human. The last demands freedom, democratic or representative forms of government, as the only forms compatable with the dignity and worth of the individual. The first results, I think, in a stable society the watch words of which are authority, routine, security. The second produces inevitably a *changing* society the watch words of which are adventure, research and progress.

Perhaps I have said enough to make clear what are the fundamental differences between the emotional, superstitious approach to life and the scientific, rational approach. But I wish to make at once one application to our present social and political situation. All over the world today the

forces of reaction are in the saddle. How can they be recognized? Here are their infallible earmarks. Wherever the freedom of thought, speech and action are being suppressed, no matter what the shibboleth; wherever the appeal is primarily emotional and uninformed, there you confront a reactionary; there you are going back to the method of hunch and prejudice and superstition and its inevitable accompaniment authoritarianism, which has underlain all the civilizations of the past and from which the advance of science has been struggling for three hundred years to free mankind. An ardent reformer said to me recently, "Why is it that scientists and engineers are always conservatives?" I said, "My dear Sir, let us begin by defining our terms. The scientist and the engineer are both men who have learned by a life time of experience and study that there is practically no possibility of progress that is built upon 'hooey'—that is not built upon the definite knowledge that *has already been acquired.* We see in our own field of physics many levitators and perpetual-motion enthusiasts who are utterly ignorant of what has been learned, and who are therefore just beating the air, depending essentially upon incantations and magic instead of upon hard-earned knowledge. They are simply living in the pre-scientific age and approaching life from that bygone standpoint, and we feel sure that they must have their counterparts in all the fields of knowledge. These are our most dangerous reactionaries no matter what sort of liberal or even radical flags they may fly."

Again, any man in authority who selects as his advisors, not the men who are recognized by their fellows in their own fields as the most informed, most competent, most trustworthy, most high-minded men in those fields, whether that field be physics or law or finance or government, but instead the men whom he personally likes or who hold his particular prejudices and preconceptions, is a *very dangerous reactionary.* He too belongs in the pre-scientific age.

But what is the bearing of these philosophical and historical remarks upon the activities of the United States Institute for Textile Research? I suppose the hope that was in Mr. Garvan's mind when he asked me to address you was that the experiences of a rather long life devoted to somewhat similar enterprises might stimulate you to keep on in the never-ending, and also in the expensive, effort continually to improve processes and methods; stimulate you, too, to hold with steadfast conviction to the view that the method of a continuously *changing* industry—of adventure, research and progress—is a worthier one than that of stability and security through the putting away of reserves, instead of venturing with them, even if the latter alternative is a possible one. As fellow researchers, then, let me spend a little time just in comparing notes and swapping experiences.

I was present as a lad of seven at the Philadelphia Centennial Exposition in 1876 when the Bell Telephone was given its first important public demonstration. Today, I suppose the Bell Laboratories have the largest research organization in the world and I know of no other that has made more spectacular progress, incomparably greater than that made in any other country when measured by the importance of the new devices that have resulted from that research, or from the very wide extension of telephone service among the population that these researches have made possible.

I myself have lived through, seen at first hand, the whole of that development and been greatly stimulated by it to confidence in the method,

as have all the others who have known it intimately. Gen. J. J. Carty, whom I knew exceedingly well, felt it his especial mission to recite to American industry from the housetops the large values in dollars to his company that had followed from spending so much money on research, for he felt that American progress depended upon inducing many other industries to go and do likewise. In 1929 he made an address before the National Electric Light Association on "Science and Industrial Progress," which is obtainable in the "Reprint and Circular Series of the National Research Council." In this address he gave some striking figures as to the saving to the public in another industry than his own, namely the lighting industry, that had been brought about directly by the research activities, mainly, of the General Electric Company. Taking the actual use of the incandescent lamp in the United States alone in the year 1928, and estimating what that would have cost if supplied by the best carbon filament lamp of 1907, he computed that the light-consuming public had been saved in that year alone $2,256,000,000.

This looks like excellent research propaganda, but I know that the question which some people would like to have me discuss is this: Do these advances, definitely brought about by research in the art of communications and in lighting, bring any offsetting social ills in their train? To get a dependable answer to that sort of a question we must look carefully at the type of industry under consideration. So far as these two industries are concerned my own answer is that I do not see how anyone can fairly say that they do. Quite the contrary, for the increasing social wants that they have created have taken up the unemployment that would otherwise have resulted from advances that displaced labor in other fields. These were completely *new* industries, developed wholly within my lifetime, so that one would not expect that research in them would produce serious unemployment. Let us all agree then that these two industries have been an unmitigated social blessing.

But the admission that labor has been displaced in other fields brings up at once the larger and more controversial problem. Whatever may have been the beneficient effect of advances due to research in communications and in lighting, may not the rate of change due to research activities in general be so rapid as to bring about serious social maladjustments? This is often claimed and, in trying to get an answer to it, I wish first to consider the United States alone and then to extend the consideration to international relations.

So far as, from my somewhat limited outlook, I can see the situation within the United States I cannot find any evidence that technological unemployment can fairly be made the goat for the present situation to any appreciable degree. Distressing individual cases occur and greatly distort the perspective of writers who come into contact with them and who do not see the counter-balancing gains. The complaint long antedates the scientific age, and I think a little reading of history shows that it has always been enormously overdone. In general, the writer who complains about it is too close to a given situation to see what is happening on the whole. I recently found a book in the Huntington Library which complained that London was over-populated in 1600 A.D. and that someone who was introducing a foot pedal to turn a wheel for sharpening needles was "taking the bread out of the mouths" of those who sharpened them by hand. In the United States we have indeed displaced an enormous amount of farm labor

within the past century. If we had not done so I myself would be really usefully employed now in milking the cows and bedding down the horses, rather than in expressing unimportant views at this dinner. I myself don't feel injured by the change; nor do most of the other farmers who have left the farm since they don't seem to want to go back. A few years ago I quoted, here in New York, statistics from the U. S. census, that seem to me to tell the long-range story in the United States pretty dependably. These statistics show that the actual percentage of the population "gainfully employed" has slowly increased decade by decade from 34.7% in 1880 to 39.8% in 1930. This seems to show fairly conclusively that, in this very period in which our technical advances have been most rapid (1880–1930), those thrown out of one industry in the United States have rapidly been absorbed into others, *and then some*, since the actual percentage keeps on increasing. I wondered if this were not due to the recent increased employment of women, but found that during the same years the increase for women has been from 18.8% to 22.2%, an increase not sensibly larger than the general increase quoted above.

Inside the United States then I can myself find no evidence that technological unemployment is a serious, long-range factor in our unemployment situation. Your own organization is avowedly trying to cheapen cost, and improve products through research, and if you succeed it not only helps you but it helps equally the public, since it enables it to wear more and better clothes for less money. True, you may employ less labor, but the money that you have saved the buying public is ready to employ that labor to satisfy its new wants *which are limitless*, and my figures seem to show that it does it, at least within the United States. If there is any reputable economist who believes in the economics of scarcity as opposed to the economics of abundance, I don't know who he is. As I understand my economic friends there is general agreement among them that the only way to improve appreciably the general well-being of this country is in some way to increase the total quantity of goods and services to be consumed; *i.e.*, to get us all to working more effectively, or harder or longer. That is precisely what your research activities are aimed at; namely, to produce more and better goods at lower cost so that more people can enjoy them. That as I see it, both from your point of view and that of the country, is the correct approach to the problem. The displacement of labor by these improved processes may indeed require some temporary adjusting, but I can find no evidence whatever that in the long run the expanding wants of our society do not rapidly take up the slack resulting from this sort of a change. If there is a saturation point for physical wants—and we cannot as yet even glimpse it afar off—there is certainly none for mental wants. For example:

The need for *education* in a democracy knows and can know no saturation point. The need for it is painfully evident today with hundreds of thousands of voters enlisting under paper-money, or redistribution-of-wealth, banners without having the remotest idea of what it all means, or the disasters that the success of their slogans would bring upon themselves and their children. If they could all be made to read and understand a few simple statistics such as are found in the income tax reports, or in The Brookings Institute publications, how the crowds that now follow the demagogue would evaporate. Is there no way to get the average American voter merely to glance at income tax reports compared with the total

income of the country, and thus discover that at least 80 or 85% of the total income of the country is already in the hands of families which get less than $2,500 a year, the limit at which the federal income tax for a family begins? Is there no way to show that average citizen that, so far as any social result is concerned, the slogan "soak the rich" means simply soak the family that already lives on less than $2,500 a year, and that unless it is thought desirable to equate incomes irrespective of services, and that means equalize the incomes of the $1,000, the $1,500, the $2,000, and the $2,500 workers (and even Russia has abandoned that kind of communism because it destroyed production) there is no possibility of improving appreciably the average well-being of the people of the United States by any mere redistribution of either wealth or of income.

But since I have now wandered outside my subject, and indeed my field, come back with me to the consideration of the effect of the rapid advance in technical processes, not now on the United States, but on the countries of Europe. In the field of agriculture I cannot make such statements as I have made above about certain other industries. The development and use of machine-farming in the United States, Argentine and other new countries has indeed tended to produce real and serious disturbances in the life of agricultural countries of Europe. The European peasant does his farming now much as he did it a thousand years ago. He cannot change his methods on his little, one-family, 15–25 acre farm to meet the competition of the big machine-run farm of the new world. To slow down the rapidity of the change which scientific improvements of all sorts in agriculture are forcing upon him, the European governments have resorted to agricultural tariffs, bounties and subsidies of many sorts. This is done deliberately *to slow down the rate of change due to our scientific progress.* Whether we like it or not the protective principle is now in use the world over. We ourselves have always used it for two alleged reasons: (1) to protect our infant industries, and (2) to maintain what we called the American standard of wages, or standard of living. We have not used it in general to protect our industries against the greater effectiveness of other countries in cheapening production through their activity in the making of scientific and technical advances (this statement may not be strictly true with respect to the German chemical industry). Outside countries have in the main exactly reversed this procedure, and though they have old industries and cheap labor have barred out our automobiles (to use a particular illustration) because they couldn't compete with our technical equipment. We think their course is economically unsound, and they think ours is, and we are probably both right if we are considering an equilibrium condition, but as a stabilizer against *a too rapid rate of change* both of our procedures are probably justifiable, if not necessary. Whether we like it or not they are here and it looks as though they would stay here. At any rate, however, we have absolutely no choice in international competition but to try our best to make up for our disadvantage in the matter of labor costs by increased effectiveness in scientific and technical procedures.

I come out then, in my discussion of "where our science is leading us industrially and what if anything we ought to be doing about it," with the conclusion that our supreme duty to ourselves and to mankind is to keep it going just as hard and as fast as we can. Let others put the brakes on the pace of scientific progress to maintain "*social stability*" if they think they

must to prevent too rapid change. For us the course of science must be broadened—not arrested. In Sir Daniel Hall's words, "Sparta achieved social stability and died. The spirit of Athens is yet active in every field of human endeavor."

Just one more idea and I am done. Research pays because you know what you want, go after it with informed brains by the scientific method, and in general get it; but it often yields double dividends because you get something more that you didn't go after. One single recent experience, which I could duplicate from my own life a dozen times: When the Metropolitan Water Board of Southern California confronted the job of transporting the largest product of volume of water by head that had ever been attempted from Hoover dam to the Los Angeles area, they became sold to the idea of putting about $180,000 into a hydraulic research plant at the California Institute of Technology, to be certain that they got that water transported through the pumps and channels with the maximum of efficiency and the minimum of turbulent loss. They borrowed the money from the R.F.C. and the latter's engineers cancelled the appropriation as unjustified expense. I wrote them a letter telling them what had been already accomplished in reducing turbulent losses in the wind tunnel at the Institute, and showed them if we could do less than a tenth as well and eliminate but 1% of the transmission loss the Water Board would save $57,000 per year. The appropriation was finally allowed. A few weeks ago I received a letter from chief engineer Weymouth stating that that laboratory had already saved the Metropolitan Water Board, before a drop of water has been transported, $2,700,000 and he itemized just how construction costs had already been definitely reduced by that amount, because we know now through a year of tests, under precisely the conditions of service, just what the performance of the pumps, when they are installed, is going to be, and can now write specifications and take bids without any guess work whatever. The pump companies had all of them recommended more expensive types of pumps than it has been found necessary to use. This item of saving alone amounted to $1,600,000 and other installation items have made up the balance. The saving in the efficiency of transmission is still to come. Has it paid the Metropolitan Water Board to do a little preliminary industrial Research? Might it not pay you in some similar fashion double dividends?

Address of Dr. J. R. Katz

Director of U. S. Institute's Warp Sizing Research

MR. PRESIDENT, Ladies and Gentlemen, and members and guests of the Textile Institute: I should like to speak a few words about the biochemical side of the problem which your other speakers have seen chiefly from the chemical side. I want to speak in the first place about the recent understanding we have of the form of the molecules of the chief substances which build up textile fibres.

You may know that all these substances like cellulose, silk fibroin, wool keratin, are now called highly polymerized substances (substances of a high molecular weight) in which a given unit is supposed to repeat itself regularly along the line of a chain-form molecule; and it may be interesting to draw your attention to the effect of this kind of understanding. It has been

brought about by the introduction of a new method of research, which illuminated the subject to such an extent that certainly a lot of knowledge that had been correct formerly, but which wasn't really understood, found its proper value, so that the whole subject became systematically understood instead of being chaotic.

It is a great thing when there is a real collective opinion, an opinion to which everyone agrees. When I look back to the state of the chemistry of the high-molecular-weight substances twenty years ago, I would say that the chief difficulty was that we did not have a collective opinion of this kind.

New methods of research were introduced into the study of the subject, such as X-ray photography. Two men in Germany first used this method. What came out of it was a very surprising effect. There were two methods, and how could these two be reconciled? The reconciliation was first made by an American. He gave the right explanation. He said that what we find is the X-ray pattern. It shows a low molecular weight. It is not formed by molecules, but is formed by bundles, and in these molecules is a certain unit that repeats regularly along a chain; and what we find is the molecular weight, not of the whole molecule, but of the two units together that repeat themselves. When that opinion was once formed, we saw that a lot of facts, that had been known for a long time, could be grouped in an orderly way.

Then the matter of X-ray photography brought a lot of other problems to a new point of understanding. You all know the well-known fact that cellulose will absorb more water than native cellulose; but it was found that there were two different patterns and two different substances, because each X-ray pattern showed a special type of crystals and showed the same chemical condition. We do not understand what is the difference between the two forms, but it is very certain (it seems more certain every year) that it is a chemical difference, because we can make acetates from the native form and they have a different X-ray pattern in the acetate form than in the mercerized form.

In the shortening and stretching of wool you will find the same thing. If you take wool fibre and make it wet and warm, you can extend it to 60, 80, or more percentage of its length, and if you lay it in warm water it will jump back to its original length. It is an effect of great practical importance. If you stretch a wool fibre, you actually stretch the molecules of the wool.

Then another important fact was that of soluble and insoluble silk of different X-ray patterns.

In sizing agents, too, a certain amount of understanding was reached. When a gelatin solution is evaporated, it is not gelatinized, and we find that it is entirely amorphous. If we allow it to gelatinize and then dry it out, we find it is a crystalline substance. Therefore, we have two forms of gelatin: the one which we get in the sizing of yarns, which is the amorphous form, because it has been dried out, and the other the gelatin form.

Last, but not least, in the case of starch we find that gelatinized starch has a totally different X-ray pattern. All the collodial changes hang together with the primary changes in the molecules. We do not understand why starch is so extremely complicated. If we have, for instance, an oxidized starch, we have probably a lot of unchanged molecules, which perhaps have the form of long chains, as in the case of cellulose.

What has come out of this analysis is that we have at least three groups

of phenomena overlying one another: the primary changes in the molecule and in the crystals; the typical collodial changes, which have been defined as surface phenomena on the surface of crystals, and different groups of crystals in relation to higher units; and, in the third place, some remnant of the original structure.

But, as we have found these facts in principle, we can expect that it is a very good time for making fundamental research about textile chemistry and textile physics.

I think it is a very happy fact that in this country such a strong interest in textile research is awakening, and that there is a Textile Foundation, and an organization like the United States Institute for Textile Research conducted on a large scale, because I should say that the time is especially good for undertaking research. We are beginning to be able to understand the real complications and the real essence of the phenomena.

The Cotton Classer Uses the Polarizing Microscope

By CHESLER L. PATTEE *

IN looking back one year, the outstanding feature of the 1934 annual meeting was the discussion of ways and means for the interpretation to industry of scientific textile research. Tonight we are again concerned with this all-important link, and the speakers here tonight should throw considerable light on this phase of scientific achievement.

This evening I have been asked to cover briefly the application of research to the technology of the cotton fibre, but before going on I would like to call your attention to one feature of your monthly bulletin *Textile Research*, namely, the well-selected quotations that usually appear on the covers. In speaking for myself (as one not continuously engaged in research matters) the inspiration and stimulation derived from concentrating for about one full minute on these valuable excerpts, is a most beneficial introduction to the reading matter within. I do not doubt that many other readers have also experienced the same feeling.

In confining my subject to cotton, I have at my disposal probably one of the oldest, widest known, most valuable, and extremely versatile textile products known to man. A recent description of this commodity runs as follows:

"Cotton is the overcoat of a seed that is planted in the southern states in the spring, mortgaged in the summer, and plowed-under in the fall. The fibre varies in color and weight, and the man who can guess the nearest to the length of the fibres is called a cotton man by the public, a fool by the farmer, and a poor business man by his creditors. The price of cotton is fixed in New York (or Washington??), and goes up when you have sold, and down when you have bought. A buyer was once sent by a group of mills to New York to watch the market, and after a few days deliberation, wired his firm as follows: 'Some think it will go up, some think it will go down. I do too. Whatever you do will be wrong. Act at once.'"

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Characteristics of the Cotton Fibre

Getting down to the more serious matters of this paper, I will set forth a few characteristics regarding this fibre. The length of staple varies from approximately ½ inch in the Indian and similar types, to about 1¾ inches in the Sea Island and Egyptian, while the large bulk of American grown cotton ranges between ⅞ of in inch and 1 1/16 inches in length. In general, the ribbon-width varies with the types from 10 to 24 microns, while the strictly American classifications will run from 14 to 18 microns.

Ordinarily, the tensile strength of the individual fully-developed fibre will vary from about 40 grains in the longer staples to over 100 grains in the coarser growths; American types will usually run from 60 to 80 grains for 15/16-inch cotton.

The growth of the cotton fibre on the plant is indeed most interesting and complex.[1] Within three to five days from flowering, the fibre starts its formation and almost immediately reaches its ultimate diameter. At this time the fibre is less than 1/10th of a millimeter in length, and is to subsequently enlarge itself longitudinally over 250 fold during the next 25 days. Picture this, if you will, as the length more than doubling the diameter during each hour of this growing period.

The fibre-wall at this stage is not, however, being completed as it lengthens, for it is composed only of a primary wall encased in a cuticle, which bears the natural waxes and oils we are so concerned with in later processing. After the full length is thus reached, another 20 to 25 days is consumed in the formation of the secondary wall.

Some authorities have pictured the secondary wall as being successively laid down upon the inside of the primary wall in daily growth-rings,[2] arranging itself in an irregular helical pattern, and changing its direction at will from time to time. In a highly matured fibre, this deposit continues until the lumen is reduced to but a fraction of the original diameter. Upon the bursting of the boll, the cell-fluids dry up and the familiar convolutions set in from lack of internal support.

Commercially,[3] cotton is valued in accordance with its (1) staple-length, (2) grade, which includes color, foreign matter, and preparation, and (3) character, which covers a multitude of attributes which have not as yet been reduced to measurement. Ordinarily "character" includes such items as (*a*) body (whether the sample is hard or soft, or has a firmness or drag when pulled), (*b*) strength, (*c*) uniformity of staple-length, and (*d*) silkiness, as compared with a high degree of crinkle.

Cotton Character

These are all characteristics to be observed during the manipulation of the sample by the human hand, and are subject to any deficiencies in the nerve system of mankind. In a broad sense, the factors of "character" can largely be determined by microscopic analysis, and it is believed by the writer that determinations by this method (or by other scientific means) may eventually be recognized commercially as specifications having a direct bearing on the premium or discount value as compared with basis.

In using a low-powered microscope with axial transmitted light, we can observe the fineness of the sample and also the amount of convolutions present. By using plane-polarized light, or better still elliptically-polarized light,[4] the degree of maturity can be determined.

These three factors (namely, fineness, spirality, and maturity) describe very well I believe the word "character" as popularly applied, with the possible exception of uniformity, which can be analyzed by means of a Suter-Webb Duplex Fibre Sorter or similar apparatus. In combination, it would seem that the chances of a formula to compute that elusive demon called "spinnability" is not far away.

Fineness[2] is important in the strength of the final yarn, by reason that intrinsically, as between two equally well-developed fibres, the finer sample has a higher tensile strength per unit-weight per centimeter. This has been amply demonstrated by various authorities.

The number of convolutions per unit-length is also believed to have an important bearing upon the spun-yarn strength. Although slipperiness is probably desirable during the drafting processes, the interlocking of convolutions in the yarn should put a greater number of fibres to work in resisting fracture at any given point.

Control of Immature Fibre Percentage

The maturity, which is a measurement of the degree of thickening in the secondary wall, determines with fair accuracy the individual fibre-strength, and also to a more significant degree the clearness of the yarn and the even-dyeing characteristics in later processing.[5] I have been requested to dwell a little on this matter of maturity, as a number of recent observers have correlated the spinnability with this factor, and with quite satisfactory results.[6, 7, 8]

Having a problem arise concerning product research about three years ago, I found it necessary to control the percent of thin-walled fibres during the test period. No means was readily available to accomplish this outside of purely optical apparatus, which was promptly procured and set up. For a year and a half records were kept of nep-frequency and yarn strengths. No attempt was made to record fineness or staple-length distribution, but the mean length was held nearly constant during the survey. The results were very satisfactory. How important we found the factor of maturity can be comprehended by the following observations as applied to $1\frac{1}{16}$ inch cotton: by cutting the maturity rating in halves (for example, from 80 to 40) the writer would anticipate an increase in nep-frequency of over 6 times, and a loss in tensile strength of approximately 15 pounds for 21s yarn. This is, of course, assuming that the factors of ribbon-width, and staple-length distribution, are constant. I will not go into the actual technique of this system of measurement, because anyone will find adequate literature available to at least introduce him to the subject.[1, 4, 6, 7] The phenomenon displayed by elliptically-polarized light is fundamentally due to a difference in orientation of structure,[4] and is for all practical purposes independent of fibre diameter.[7] Research by means of polarized-fluorescence,[9] and by X-ray diffraction patterns[10, 11] support this contention admirably, and it makes but little difference whether one favors the micellar or the cellulose-particle theory.[12]

Broad Field for Cotton Research

Scientific research as applied to cotton is not limited to the optical field by any means. There is a wide sphere in both the chemical and

physical ends of research, which include such studies as pertain to dyeing, mercerizing, bleaching, and warp sizing; also wearing and launderability, shrinking, moisture-control, and so forth. The recent studies on deterioration due to micro-organisms [12] seem to promise valuable contributions.

It would seem that with the many combinations of twists and weaves that have been tried out in the past, further developments are to be related toward the usefulness of the cotton fibre in combining with it other natural or synthetic products. In this connection I have in mind, for example, the new fused collar, which retains its natural-born stiffness regardless of severity of the weather, or cruelty on the part of the laundryman. By this I do not wish to insinuate that the laundries are the only group responsible for our clothes wearing out, although they are frequently so accused. Not at all! A little study here will bring forth astounding information as to abuse on the part of the garment-owner. I may add that probably few of us realize the research that is being done by the laundry associations. They are bidding fair to supply a major contribution to the long-wearing qualities of our wash goods.

Then we have cotton in combination with Bakelite or other plastics. Another substance of growing importance is Lastex, wherein we find a product of almost permanent resilience, capable of being bleached and finished with its cotton carrier, and, subsequently in the hands of the consumer, of continued wear and launderings without sign of fatigue.

Crop control is another fertile field for research. In this connection the Textile Foundation is reported as having diverted a part of their funds to aid in the study of agricultural methods. Mongrelized seed, through cross-pollination and the use of gin-run stocks, is said to constitute over 90% of that which is planted annually. This has resulted in short, wastey, partially developed lint of poor spinning quality. Here, again, the maturity microscope steps in to play an important part.

May I again stress that the findings of science be reduced to simple and effective interpretations. The average business executive has but little opportunity to become research-minded in its literal sense. I care not what his training has been, if he is today actively engaged in steering a modern ship of industry, the more or less abstract findings of science are like a distant shore in the early morning haze. Unless his ship is badly off its course, he will not raise binoculars to his eyes to identify it. On the other hand, there may be a treasure on that shore, but it will pass by unnoticed unless somebody is there to call it to his attention.

The advances of science *must* be sold in the market like any other commodity. Having found one of genuine value, give it an attractive wrapping, engage a competent salesman, and your chances of putting it across will be strengthened many times over.

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Scientific Wool Top Standardization to Meet Commercial Conditions

By E. O. KRUEGEL *

CORRECT judgment of wool quality has been the foundation upon which our wool manufacturing industry has been built and upon which the future largely depends. The term quality usually is interpreted to mean superiority, but when it comes to defining wool quality in less general terms we come up against the difficulty that quality as applied to wool has never been accurately defined. Quality to the top maker immediately reflects superiority of physical characteristics of the fibres, while to the manufacturer this term means excellence in manufacturing performance.

In recent years the term quality has been more and more universally applied to such physical characteristics as fineness, staple, strength, color, and handle, while the manufacturing performance has been designated by the term "spinning value." Since both of these criteria of superiority in wool are closely related, scientific investigations have been carried on for many years at finding some common value by which these two factors of superiority may be expressed.

Although spinning value may be fairly accurately estimated by an experienced spinner, the fact still remains that a spinning frame is the only reliable test for a top's performance. Since this value is dependent on several properties of the fibre, such as fineness, length, surface structure and serrations, which are all commensurable, as well as elasticity, shrinking ability, torsional strength, and natural cohesive tendency, which cannot be

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conveniently measured, any scientific determination would either be incomplete or would require much more time than the average tradesman could afford to spend. Further, the actual "spin" of a top is often very different from the estimated, due to processing. There are normally from six to twelve operations from top to yarn, each contributing something to the ultimate result. The efficiency maintained in these processes determines whether or not the "spin" is impaired or remains the same. Draft, twist, system of spinning, and atmospheric conditions influence the limit "spin." To sum up, the spinning value of a top is indicated only by the good yarn obtained from it when spun to limiting counts under correct spinning conditions, and cannot be predicted with surety. Thus, with scientists completely overlooking the commercial practicability of their investigations, the average merchant came to believe that scientific classification of wool top quality attributes was nothing more than an interesting academic study. Since 1928, however, several practical methods for the determination of such important attributes of top quality as fineness, staple and strength have been put forth both in this country and abroad.

Practicable Basis of Scientific Top Grading

Wool sorting is based primarily on fineness of fiber, staple length, strength, color and handle. It would seem likely then that these attributes should also be the basis of scientific gradation of top. Crimp, contour, scaliness, plasticity, and many other physical and chemical characteristics of the fibre have been advanced by various investigators as being important to quality. Since it is doubtful whether these characteristics are, to the wool sorter, more than an additional check on fineness and handle, the conclusion may be drawn that measurements of these characteristics are indicative of spinning value rather than of quality.

If top quality be taken as 100%, then it may be said that fineness of fibre, in conjunction with fibre distribution, staple length, and fibre strength, contribute 80%. Color and handle contribute the remaining 20%.

In order that a top may be analyzed for fineness, staple and strength in commercial practice, certain requisites must be fulfilled by the methods employed. First, each of the attributes must be determined with reasonable speed. Top appraisers rarely require more than one-half hour to evaluate a top's quality against a standard. Second, both the method and technique must be relatively simple. Third, the final result must be representative of those factors which appraisers deem important to quality.

Cross-Sectional and "Wedge" Methods

The fineness of wool tops has been expressed as weight per unit length, cross-sectional area and diameter. The weight-per-unit-length method necessitates careful parallelization of the fibre, cutting to a definite length under fairly even tension, counting, and then washing, drying and weighing under controlled conditions. Because of this rather lengthy and exacting preparatory technique the method is hardly adaptable to commercial practice. Aside from this objectionable time feature, this method renders no data as to the distribution of the fibres; a factor that is *vitally necessary* in the assessment of a top's fineness.

The cross-sectional area method, although giving the fineness distribu-

tion of the fibres, again has several features which do not lend themselves readily to *commercial application*. First, cross-sections of wool top cut by the rapid sectioning methods are open to a large number of uncontrollable errors. If the sections are cut by a proper candle method, the time becomes too great and the technique too involved.

Perhaps the method that has received the most favorable acceptance in the trade is a modified form of the so-called "wedge method." It consists of drawing a random sample from the top. This sample is then mounted on a glass slide and placed on the stage of a projection microscope. The diameters of the fibres are then measured by means of a properly calibrated "wedge" ruler. From this ruler it is a simple matter to determine the fibre distribution and average fineness.

The Staple Diagram and Its Basis

Before discussing the significance of top fineness measurements, let us examine how the wool sorter determines his quality limits. In sorting for a quality, the wool sorter sets up a limit as to the finest and coarsest staple or group of fibres that can normally go into the make-up of that quality. Further, the wool sorter will always associate the same range, or dispersion of fineness, with that quality, no matter when or from what fleeces the sort may be made. Therefore, the range or dispersion of the fineness attribute of a group of matchings of a quality will be substantially the same. Also, in a lot of matchings there will be groups of fibres that have the same diameter. Any one fibre chosen from such a group at random is representative of a group of fibres of the same diameter. These matchings are then blended anywhere from 300,000 to 1,000,000 times from matchings to top. Therefore, any small group of fibres taken from a top will be similar to any other small group that may be chosen, so far as make-up is concerned. Also, the statement may be made that any one fibre taken from one of these small groups will represent a group of fibres of the same diameter. Since the dispersion factor for the fineness of a quality as set up by the wool sorter is a constant, and if any small sample drawn from a top is similar to any other that may be drawn, and if the fibres in any one of these small samples are representative of all the fibres in the top, then it must follow that any series of measurements on that quality should have a constant dispersion factor. If this last statement were untrue then fineness could not be determined by measurement and still be reliable. But tests over a period of years have shown this dispersion factor, called statistically the standard deviation, to be a constant. Thus it is possible to predict by the theorem of probability what the dispersion or range of fineness of a type will be. Knowing this range it is possible to standardize the type as to fibre distribution and average diameter.

Staple, the second attribute of quality, is of major importance to top maker and manufacturer. In general, the more alike in length are all the fibres in a top the better will be the "spin" and evenness of the yarn. However, this must not be interpreted to mean that a top, all of whose fibres are, say, one inch long, will spin as well as one that has fibres ranging from two to four inches. Here, as in fineness, the correct proportioning of the distribution is dependent on the counts to be spun, the system of spinning, and the type of preparatory machinery. In the past too much stress has been placed on the longest fibre in the top, and also on the

average fibre length. Neither of these values gives any indication as to the top's performance. On the other hand, it is the amount of short fibres in the top that is the enemy of good yarn production, especially on the Bradford system. This factor of short fibre is of special interest in present day manufacturing, since all top makers are trying to get from the wool as much top and as little noil as possible. A top with a large amount of short fibre processed on an ordinary gill box is certain to be troublesome.

It is to study the top for these characteristics that the staple diagram is most useful. Several methods for the determination of this diagram have been proposed with a greater or less degree of practicability. The one that has received the widest application in this country is a mechanical reproduction of the manual method used by the trade for many years. Each group as sorted into lengths by the machine is weighed, and the figures so obtained plotted graphically, expressing the fibre length in centimeters against percentage weight in each group. These diagrams are important to the top maker, in that differences in combing and noil yield of the same lots of wool can readily be detected. To the manufacturer the diagrams will give information as to the type and setting of the machinery necessary to process the top with the greatest efficiency.

Possible Scientific Strength Indicator

Scientific top strength determination by the proposed single fibre methods has had little application commercially, due to the elaborate methods employed. Since it is impossible to predict the true yarn strength from this method, due to the fact that yarn strength is also dependent on twist and surface structure of the fibres, there seems to be no reason why less complicated methods should not be used for simple comparative purposes. In the trade, strength is determined by snapping the staple with the finger. If the staple is resonant, the top is strong; if it breaks, it is weak. After many years of experience a top appraiser is able to judge the relative strength of the top by the degree of resonance of the staple. But his conclusions do not necessarily agree with those of another appraiser. Thus it has been suggested that if the staple were cut to a definite length, weighed and then broken, the ratio of the machine strength to the weight would be a measure of the strength. Experiments have been carried out using this method and the agreement between the yarn strength of comparative top spun to the same counts and twist has been fair. There is, however, much more work to be done before this method can be definitely proposed for commercial practice.

Factors Impeding Scientific Standardization

In recent years the rigid gradation of top has fallen into a decline due, undoubtedly, to the low level of wool prices and the demand for increased sorting room production. The factor that has allowed this to go on unprotested by the manufacturer is that tops were not spun to their respective limit counts. Tops were bought of average fine quality whose limit "spin" may have been 46s, yet the manufacturer may have spun this top to 32s. The top maker was in a position to allow coarse fibres in his fine blends to pass without any serious objection.

Today, with wool prices again reaching a firmer tone, sorting and rigid

top gradation has come into prominence. This factor, together with the desire by manufacturer and merchant alike to have a better understanding of wool, have brought scientific measurements of top quality attributes to the foreground. Another factor that has advanced the art of top measurements is the obvious difference that exists between the Official U. S. Government Top Standards and the generally accepted commercial types. Merchants realized that a difference did exist, but they were unable to justify their reactions. Thus, there is little wonder that top quality standardization has been a vital topic of discussion. Attempts have been made both in this country and abroad to reach some common international standard with which tops from all countries can be compared. This, however, is difficult because of two important reasons: First, manufacturing requirements in each country are different, due to differences in prices of greasy wool, in cost of labor and in types of wool normally grown in each country. Second, in commercial practice qualities are governed by the manufacturing and finishing properties which the wool is to give to the final product.

Let us illustrate the first point. This country has a relatively high cost of labor. The finished product, however, must be produced to meet a certain price so as to meet competition. Therefore, careful sorting has, in the majority of cases, given way to "trapping." Now this procedure introduces characteristics into a top that cannot be evaluated by comparison with tops from carefully sorted fleeces such as the Official Standards. Now it is doubtful whether or not "trapping" has such a detrimental effect on top quality as some manufacturers would lead you to believe. If tops are to be spun to their respective limit counts, then these "trapping" characteristics would be troublesome; but with current practice being not to spin to limit counts it appears that no serious effect will be noticeable.

Official Standards Should "Go American"

There is at the present time a very serious movement under way to change the Official Standards to conform more nearly with current trade practice. In order for a wool standard to be valid in this country it must meet the following requisites: First, the qualities that the standard is to represent must be representative of the trade types. Second, since 80% of all the fine, three-eighths and quarter-blood wool used in this country are American types, the top standards should also be of American wool. Third, the standards should be substantiated by approved scientific measurements so that they are, (*a*) reproducible, and (*b*) that the limits of fineness and staple can be *clearly* defined.

The importance of these contributing factors of wool top quality standards is clearly realized by the trade, and unless the Official Standards are brought in line with these requisites they will not receive recognition nor the use for which they were originally intended.

Silk Filaments' Shape and Size Cause Two-Tone Dyeing

By F. A. MENNERICH *

IN the dyeing of knitted silk fabrics the appearance of slight color differences in adjoining sections of the same fabric is of frequent occurrence, and the cause of sub-standard merchandise and great financial loss. In silk stockings the trouble is exhibited by a sharp demarcation between the leg and foot portions.

It is commonly stated that differences in shade are due to chemical causes, such as differences in soaking, age, oxidation, bacterial action, tinting, natural color and nature. To obviate two-tone from these causes strict uniformity of lots and similarity of treatment have been repeatedly recommended and practised. Despite all precautions taken in uniform soaking, tinting, uniformity of yarn and stitch formation, classification according to natural color, feel, or hardness, and despite all attempts made to correct the trouble by the addition of selective wetting agents in the dye bath, two-tone still persists in developing due to some inherent physical quality of the raw silk.

Discovery of Principal Cause of Two-Tone

For five months I tried to find a leveling agent which would eliminate two-tone dyeing. Oils, soaps, solvents and numerous chemicals were tried, but none of them proved successful. They would not level out the inherent two-tone.

After hundreds of failures, I began to doubt whether two-tone was really due to chemical differences. I came to the conclusion that the real cause must be in physical differences of the silk filaments.

When the silk filaments were examined from a cross-section at 500 diameters, there seemed to be a difference in the shape and size of the filaments. The difference in shape was obtained from the diameter ratio, which is defined as the ratio of the minor to the major diameter of a filament at a given cross-section. It was found that two-tone was produced when there was a difference of 0.04 in the diameter ratios.

Except in rare instances, variation in shape is not noticeable to the eye by microscopic examination. Ordinarily the unlikeness is too slight to be noticed in cross-section, except by statistical measurements, even though extremely visible as two-tone dyeing in knitted fabric.

It is peculiar that two-tone dyeing is usually not noticeable when the light- and dark-dyeing silks are examined in skein form, whether in the raw, after tinting, or after boiling-off and dyeing. Two-tone is usually noticeable only at the line of demarcation between adjacent light and dark panels. If a string is held so as to cover this line of demarcation the difference in hue seems to disappear.

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Experimental Procedure

After the raw silk is degummed or the color stripped from dyed stockings a small bundle of filaments is selected and adjusted to size by a special thread sizer. In cross-sectioning, the bundle is drawn through a tiny hole in a thin metal plate by means of a fine wire loop. The projecting ends of silk are cut off with a sharp razor blade flush with the two smooth faces of the metal plate. The metal plate is mounted upon the stage of a compound microscope strongly illuminated by the substage mirror with transmitted light from a bright carbon arc lamp. The image of the cross-section is projected at a magnification of 500 diameters upon a ground glass screen ruled co-ordinately. Measurements of the diameters are made on the ground glass by means of a small transparent celluloid scale with special graduations, so that both the minor and major diameters may be read directly in microns with one setting of the scale.

Factors Affecting Shape and Size of Filaments

It has been recognized that silk from different breeds of silk worms, and different seasons and climatic conditions show characteristic dye absorption. Through the courtesy of Mr. C. Walter Seidel, selected cocoons were obtained from the Sericultural Institute of Nakano. The data show that, for the particular cocoons tested, the shape varied with the breed, and within the same breed of cocoons varied with the latitude. Also it was apparent that the spring yellow silk was flatter than the spring white, and that the spring cocoon filaments were larger. There was a 40% variation in the shape of the filaments and a 20% variation in the size.

Relation of Two-Tone to Other Properties

From a limited number of observations, two-tone dyeing showed no consistent relationship to:

1. Feel of raw silk skeins.
2. Color of raw silk skeins.
3. Hardness, as determined by incline plane serigraph.
4. Exfoliation of raw silk.

Attempts were made to discover some relationship among all possible combinations of the following five properties, but no relationship whatsoever was found between any two of these properties: hardness, tenacity, mean diameter, diameter ratio and exfoliation.

Effect of Shape and Size of Filaments Upon Two-Tone Dyeing

In stockings, which showed no two-tone dyeing, the differences in diameters and diameter ratios were negligible. In analyzing the causes of two-tone dyeing, it was found that differences in shape accounted for 65% of the cases and that another less important factor entered the picture, namely, the size or mean diameter of filaments.

Taking a difference in diameter ratio of 0.03 as sufficient to produce two-tone dyeing, it was found that the consistency of results was 65%.

If a difference in mean diameter of 0.7 was taken as sufficient to produce two-tone dyeing, the consistency was 45%. When both differences were considered, 0.03 for diameter ratio and 0.7 micron for mean diameter, the consistency was 90%.

When all the variables involved and many other possible causes of two-tone are considered, the remarkable consistencies, with no relation existing between shape and size, seem to prove conclusively that the shape and size of the filaments are characteristic for different lots of silk and markedly affect the shade of dyeing.

Forty ten-bale lots were examined to determine the average shape and size of the filaments and their variations within and among different lots. The results are based on more than 50,000 measurements. Two-thirds of these lots could be selected as showing no two-tone within the ten-bale lots. One-fourth of the lots could be chosen as showing no two-tone either within the same lot or among different lots.

Resumé

1. One principal cause of two-tone dyeing is due to differences in shape and size of the silk filaments in adjoining sections of fabric.
2. A difference of 0.03 in diameter ratio or a difference of 0.7 micron in mean diameter is sufficient to produce two-tone dyeing.
3. The flatter and larger filaments dye darker than the rounder and smaller filaments.
4. Silk from different breeds, and possibly from various seasons and districts, are characterized by a difference in shape and size of the filaments.
5. The discovery that differences in shape and size of filaments produce two-tone should make obvious the futility of attempting to correct for two-tone by any chemical adjustments in soaking, boiling-off and dyeing when such differences exist.
6. No consistent relation was found between two-tone dyeing and other properties, such as color of raw silk, feel, hardness and exfoliation.
7. No relationship was found among such properties of raw silk as diameter ratio, mean diameter, exfoliation, hardness and tenacity.
8. By grading raw silk according to shape and size of filaments, two-tone dyeing can be minimized if ten-bale lots are so selected as to show a variation of less than 0.03 in diameter ratio and less than 0.7 micron in mean diameter. By routing ten-bale lots in throwing so that consecutive lots do not exceed this variation, about two-thirds of all lots can be used with nearly complete elimination of inherent two-tone dyeing.

It is recognized that certain variations in soaking, knitting and weaving may cause two-tone, but this discussion deals with a principal cause which is beyond the control of throwster, knitter or weaver except as the raw silk itself is selected for uniformity in shape and size of filament.

The Physicist in the Textile Industry

By DR. IRVING J. SAXL *

ONE of the most interesting applications of pure science is now taking place in the field of textiles. Compared to other realms such as electricity, optics or engineering, the scientific investigation of fundamental phenomena and the application thereof to technical developments is relatively recent in the textile industry. This is perhaps surprising in view of the fact that the manufacture of textiles is as old as human civilization. However, while organized research has yielded rich returns in such comparatively young fields as electricity and communication, the age-old textile industry has only recently begun to make use of the potentialities that lie in science.

Today, we still use the same principles of weaving as employed in Egypt 6000 years ago. The first real departure from the primitive methods took place with the invention of the synthetic fibres. However, even these, after they leave the spinning solution, are substantially treated in the same manner as of old. Individual filaments are held together by the mutual friction imparted by the twist, making use of laws for binding fibres which were discussed for hempen ropes as early as 1638 in the Discorsi e Dimonstrazioni Matematiche, pp. 56, by Galileo Galilei. With the exception of the fact that our twisting frames today are power driven, the spinning wheel methods used by our great grandmothers are physically the same. The same refers to knitting and braiding.

While the revolutionizing influence of the science of chemistry has long been applied in dyeing and finishing, it is only now that physics is being applied properly to the analysis and study of textile materials which, after all, are primarily a physical medium. They are characterized by such terms as breaking strength, elongation, elasticity, index of refraction, Poisson's ratio, dynamic characteristic—all physical terms.

If we are to improve textile products, a study must be made of the physical properties of the materials used. In this manner textile research is closely linked with the investigation of the fundamental properties of matter. Such physical characteristics as heat conductivity, permeability to air, coefficient of friction, strength, elasticity, adsorption, and many more must be investigated as to their relation to textile materials if we are to improve on the age-old technique passed down from father to son and often kept as family and factory secrets.

I have the greatest respect and admiration for our Mr. Black, who in the midst of the depression had the courage and foresight to introduce strict laboratory procedures of physical research and development into the textile field. If anywhere, such work is necessary today in the textile industry as a means of bringing in new thoughts and constructions, but also as a safeguard against unjustified claims that may be made on raw materials and manufactured goods. Today, adherence to conservative methods is suicidal in this highly competitive industry.

Let us discuss some concrete facts regarding the application of industrial physics in the manufacture and conversion of textile products.

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The Physicist in the Testing Laboratory

The duties of the textile physicist lie in three directions: one is to test the raw material coming in. It has been found that some claims from raw material producers are not always based upon actual facts. The most important raw materials in the textile laboratory are first, the fibre and yarn proper; second, materials in connection with yarn treatments such as sizing and finishing. A quantitative knowledge of the worth of yarn, gelatine and other materials is necessary. Some new experimental methods were therefore developed. In addition, their application had to be interpreted properly for finding out more about the representative characteristics of the materials purchased. Last, but not least, constant search is made to find simplification and improvement in the testing procedures, cutting down the expense of the individual test without impairing its representativeness.

A yarn, physically speaking, is a filamentous material and as such is subjected to all the laws governing materials in filamentous form. While in other fields filamentous materials have been thoroughly investigated, such as in the incandescent lamp industry and the manufacture of copper and steel cables, almost no attempt has been made to consider the yarn from the same angle. If Langmuir had not had the basis of fundamental understanding of tungsten wire, we, today, would not have the highly efficient electric lamps. The same refers to yarns. The construction of a cable consisting of a number of single strands, or the construction of a yarn consisting of a number of single filaments, is nearly related. Equally, the intermolecular construction of single copper crystals is comparable to the molecular structure of the organized molecules that constitute fibres. In both instances we have to deal with materials that are subjected to partial recovery after stress, to plastic flow, to a definite degree of deformation under the application of a specific load to materials that have a safety limit before the yield point, and should not be used for any technical purpose under conditions that are beyond the physical limitations of the flow point.

Naturally, with the yield points known for various filamentous materials, tensions during the manufacture can be properly adjusted, cloth constructions can be engineered that are capable of withstanding increased mechanical stress or have some other desired specific properties. In addition, by applying these fundamental laws during the process of manufacture the breakage of the individual yarn can be reduced during the various steps of manufacture, and thus the efficiency of the various units, such as cone creel warpers, spinning frames or automatic looms can be increased.

Novel Methods in Sizing Research

Another recent application of physical thinking lies in the investigation of sizing materials, particularly gelatines. Of all claims that the textile engineer has to deal with, the products made by some gelatine and sizing manufacturers are among the ones that need objective testing. New methods, therefore, breaking with conservative routines, had to be developed for investigating and evaluating the properties of various materials that enter sizing, particularly gelatine.

The United States Institute for Textile Research is to be congratu-

lated upon its foresight to undertake a study on sizing, and the investigation of some fundamental factors as outlined in a previous interesting talk given by Dr. Katz. Again, as in the investigation of yarn, attention must be given to the fundamental properties of materials going into sizing batches. As far as gelatines are concerned, the question boils down to the investigation of adhesion, cohesion, and resistance to abrasion, all factors that have to be investigated and controlled according to the laws of physics.

At the meeting of the Society of Rheology recently, two papers were presented, one describing new machines for measuring gelatine strength in terms of load versus compression characteristics, and another paper in which electronic methods were introduced for the first time for examining shearing strength. It may be of interest to know that the latter was made with an electromagnetic pickup that was brought into contact with a gelatine surface moving relatively to the pickup. If the surface is smooth and hard, the pickup glides over it without difficulty, but if the surface is granular and softer a greater electromotoric force will be generated in the pickup. Quantitative results are received in this manner as to the most important surface conditions of gelatines as far as they influence the sizing of yarn. I believe this is the first application of strictly electronic methods to sizing research. It also shows (what has been found in many other categories of recognition) that scientific fields developed for one specific reason may find unexpected applications in entirely different lines.

Only two of the important types of raw materials that are to be investigated by the textile laboratory have been mentioned, namely, yarn and sizing materials. There are many more to be tested, but in the short space of time allotted they cannot be discussed here.

Processing Control and Standardization

The second duty of the mill laboratory lies in the standardization of manufacturing processes. Methods of testing had to be developed for yarn lots going through the mill, and the methods of statistical research known from mathematical investigations have been applied for obtaining a representative picture of yarn characteristics with the least possible number of tests. Standardization of products during their manufacture is one of the most important points, and the laboratory man who is capable of eliminating some of the sources of variation of the mill output throughout the various manufacturing steps can protect his mill against considerable losses and create and maintain some good will on account of the constant quality his mill will be capable of delivering. Mathematical methods of statistical representation of results, development of specific tests in the various departments, and intelligent interpretation of them fall in this second class of laboratory duties. The same methods established in the principles of quality control apply also to the investigation of claims.

Products of Pure Research

Last, but not least, the third and perhaps most interesting part of the textile physicist's duties lies in pure research and development. It is here that new facts can be found and where new machines, instruments and textile products may be developed in accordance with the requirements of the industry and trade. The development of new products has to be chosen

in such a manner as to anticipate future trends if possible. Where new characteristics of materials cannot necessarily be based upon older experiences, the scientific training and creative ability of the textile physicist becomes of particular value. By going back to the underlying facts and the general physical laws, it is sometimes possible to change the structure of textile materials with methods not used heretofore in mill experience. Not only can characteristics of the material be changed in this manner, but, in addition, new manufacturing methods can be developed by introducing into the textile field methods of procedure known heretofore only in other arts. As an example, stroboscopic observation of rotating spindles utilizes electronic high frequency gaseous discharges, linking the electronic field to the control of the R.P.M. of the spindles in spinning frames. Also, Professor Schwarz's method for determining the maturity of cotton fibres by examining their appearance in polarized light is an excellent example of the value of physical methods in textile research.

Not only is it in the development of production machinery and manufacturing processes, but also in the design of new instruments fitted to the specific requirements of the various products of manufacture, that the scientist can serve his industry. Again referring to specific cases, it was possible by constructing a machine for the precise measurement of the work factor expended while a yarn crêpes to predict the crêpage of yarns with reasonable certainty. Another apparatus which fits in this line of pure research is a chain-weight yarn tester recently described, with which it is possible to determine the dynamic characteristics of yarn and similar materials under reliable and reproducable conditions. Also, with the aid of this new instrument it is possible to make an investigation of some fundamental properties of filamentous materials. Also, another specific characteristic of yarns, namely their stiffness, is now subjected to precise tests instead of relying on their "hand" and other subjective impressions. The same refers to the exact determination of the coefficient of friction of individual yarns.

In bringing about the introduction of clear and objective methods of physical testing procedure, progress is made from subjective methods towards an actual, objective knowledge of facts upon which improved methods of manufacture and improved products are based. These are just some of the many possibilities that lie in the application of industrial physics to this as yet almost virgin territory of the textile industry.

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(*Editorial continued from page 54*)

Research Salesmanship: An Institute Problem

Dr. Robert Andrews Millikan, who was the guest speaker at our recent annual dinner, was not invited solely because he is one of the world's greatest scientists, but partially because he is a supersalesman of science. He gave an effective demonstration of both attainments. If careful reading of Dr. Millikan's address will not convince one of the value of scientific research to industry—the textile industry in particular—then the salesmanship that will sell the research idea to those textile men who should have the ability to utilize it advantageously must itself be made the subject of intensive research.

Naturally, the Institute hesitates to embark upon such a study, because it could hardly fail to be interpreted as a serious indictment of the textile industry for lack of intelligence, progressiveness and adventuresomeness.

"I suppose the hope that was in Mr. Garvan's mind when he asked me to address you was that the experiences of a rather long life devoted to somewhat similar enterprises might stimulate you to keep on in the never-ending, and also in the expensive, effort continually to improve processes and methods—stimulate you too to hold with steadfast conviction to the view that the method of a continuously **changing** *industry—of adventure, research and progress—is a worthier one than that of stability and security through the putting away of reserves, instead of venturing with them, even if the latter alternative is a possible one."*—From Address of Dr. Robert A. Millikan to U. S. Institute, Nov. 14, 1935.

Color Tolerance: Its Measurement and Specification for Dyed Textiles

By ROBERT D. NUTTING *

Fellow of the Textile Foundation

THERE is, at present, no universal method employed by dyers and colorists for the measurement of color and the specification of tolerances in color matching. However, the need for color measuring instruments to assist the dyer in obtaining a desired color more easily has become increasingly evident. This requirement has been met with varying degrees of success by the numerous devices for color measurement that have been placed upon the market in recent years. It is now possible, with a correctly designed instrument to measure a color in terms of fundamental physical units with more than adequate precision. In fact, it has been shown [1] that by instrumental means it is possible to detect small color differences in dyed textiles that are not apparent to the eye.

In general, it is true that the use of such precision instruments has been limited because the results obtained are not given in terms familiar to the dyer. It is common, when speaking of two different colors, to say that one is redder or greener than the other, and such a designation will be readily understood by anyone. But when an attempt is made to designate the degree of the difference, to answer the quantitative question,—how much redder?—mere description in words is found to be inadequate. Apparently, some numerical designation is needed that will describe the amount of color exactly and at the same time have a real meaning in terms of more familiar concepts analogous to hue, saturation, and brilliance. It is further necessary that this method of specification have a universal meaning and not be limited to any one type of color measuring instrument. There are at present on the market certain instruments and systems of color measurement and specification that are useful only if all color measurements are made with the same device. That is, the results obtained with such instruments are entirely arbitrary and bear little relationship to any general system of colorimetry.

I. C. I. Color Specification

In the interest of obtaining a universally applicable system for the measurement and specification of color, the International Commission on Illumination [2] established in 1931 a procedure that may be used to convert spectrophotometric data into a universal language of color. The results obtained from this procedure are definite and unambiguous and are easy to comprehend, since they are the physical analogs of the familiar concepts of hue, saturation, and brilliance. The I. C. I. method of color specification is based upon the

* Dr. Nutting worked under the direction of Prof. Arthur C. Hardy, Dept. of Physics Massachusetts Institute of Technology, Cambridge, Mass.

well-known fact that the eye is not an analytical instrument but functions as an integrating device. This can be explained simply when it is appreciated that the sensation of color produced by an object depends upon three factors. It depends first upon the nature of the illumination by which we see the colored object; secondly, upon the reflection (or transmission) characteristics of the object itself and finally upon the visual process of the observer. We can neglect, for all practical purposes, any differences due to different observers if care is taken to standardize the observer by means of experiments carried out on numerous persons having normal color vision. The color characteristics of the illuminant and of the object may be measured in numerous ways. The fundamental method utilized in color measurement is that known as spectrophotometry, in which the reflection (or transmission) of the object is measured at each wavelength throughout the visible spectrum. The energy distribution of the illuminant is similarly measured by spectroradiometry. The characteristics of a normal human observer may also be measured once and for all by a suitable procedure that need not concern us here. In order to simulate the function of the eye for color vision, it is now only necessary to integrate the product of these three functions. This method of computation has been described in some detail elsewhere.[3]

In order to show how this universal method of color specification may be applied to the practical problem of color tolerance, numerous commercial matches have been obtained from a well known woolen house and from a cotton finishing mill. These samples were obtained in pairs, each pair representing a standard dyeing made at one time and a match dyeing made to duplicate the standard. It should be emphasized that all of the samples shown here were matches accepted by the customer as satisfactory. It is not the intent of this paper to attempt to set any tolerance limits, because it is too obvious that in the textile industry such limits are frequently regulated by elements other than color. It is recognized, however, that aside from these factors, such as price, market conditions, etc., there is a real need of a method for specifying a color tolerance that can not be abrogated because of the uncertainty with which this tolerance was established.

The Spectrophotometric Curves

The samples mentioned above have been measured with the Hardy recording photoelectric spectrophotometer,[4] using a magnesium oxide standard. To avoid any effects of weave, polarization, or irregularities in the cloth, a single thickness of the sample backed by black velvet was placed in a rotating holder of the type described elsewhere.[5] The colorimetric computations have been made assuming that the samples were illuminated with light of a quality approximating average daylight (I. C. I. Illuminant C). The trichromatic coefficients have been plotted on the color diagram in order to show directly the excitation purity and dominant wavelength of the pairs of samples. In order to show color tolerances more clearly it is preferable to use an enlarged portion of the color diagram shown in its entirety in Fig. 1. Then, that portion of the diagram in which the particular colors of immediate interest happen to fall may be studied minutely. The enlarged charts, of which portions are used here, were taken from "Handbook of Colorimetry." [6] In Fig. 2 are shown spectrophotometric curves of a pink cotton dyeing and a match dyeing made some time later. The spectrophotometric curves show that the dyeing procedure must have been altered somewhat as the samples

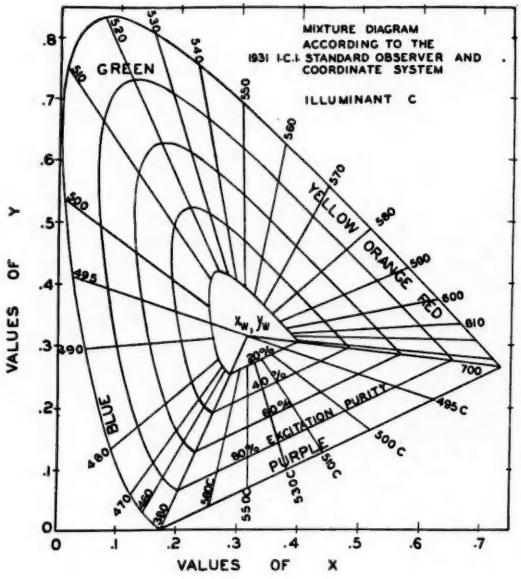
MIXTURE DIAGRAM
ACCORDING TO THE
1931 I.C.I. STANDARD OBSERVER AND
COORDINATE SYSTEM
ILLUMINANT C
GREEN
YELLOW
ORANGE
RED
BLUE
PURPLE
EXCITATION PURITY
VALUES OF Y
VALUES OF X

FIG. 1

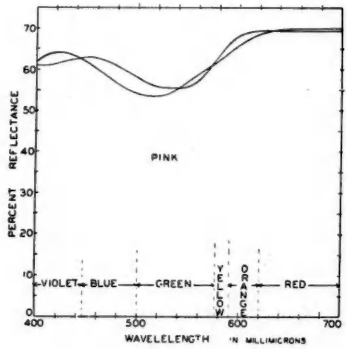
PINK
PERCENT REFLECTANCE
VIOLET
BLUE
GREEN
YELLOW
ORANGE
RED
WAVELELENGTH IN MILLIMICRONS

FIG. 2

TABLE I

Cotton Samples

Sample Designation	Tristimulus Values				Trichromatic Coefficients		Dominant Wavelength in Millimicrons	Excitation Purity in Percent	Brightness in Percent	Symbol	Figure Number
	$\Sigma\bar{x}E_cR\Delta\lambda$	$\Sigma\bar{y}E_cR\Delta\lambda$	$\Sigma\bar{z}E_cR\Delta\lambda$	Sum	x	y					
Helio	371.0	338.7	562.0	1271.7	.292	.266	565.0C	16.8	33.87	H	3
"	357.0	324.1	558.0	1239.1	.288	.262	566.3C	17.8	32.41	H	3
Pink	626.3	596.9	719.3	1942.5	.322	.307	532.0C	4.0	59.69	P	3
"	632.7	606.7	735.3	1974.7	.320	.307	552.0C	3.8	60.67	P	3
Orchid	481.0	447.4	644.4	1572.8	.306	.285	556.5C	11.8	44.74	O	3
"	512.4	480.7	674.8	1667.9	.307	.288	556.0C	10.8	48.07	O	3
Tan	468.0	474.9	417.5	1360.4	.344	.349	578.0	17.8	47.49	T	3
"	483.8	489.4	427.6	1400.8	.345	.350	578.0	18.5	48.98	T	3
Light Green	377.0	427.8	476.8	1281.6	.294	.334	505.0	5.3	42.78	LG	3
" "	407.2	460.2	530.0	1397.4	.292	.330	500.0	6.0	46.02	LG	3
Deep Gray	287.3	298.0	371.0	956.3	.301	.312	485.0	3.8	29.80	DG	3
" "	304.9	317.0	400.0	1021.9	.299	.310	485.0	4.8	31.70	DG	3
Gray	398.7	414.7	507.6	1321.0	.302	.314	486.5	3.2	41.47	G	3
"	385.9	401.8	504.2	1291.9	.299	.311	485.0	4.8	40.18	G	3
L. Blue	387.3	400.3	693.4	1481.0	.262	.270	478.2	23.0	40.03	LB	3
" "	389.8	402.6	669.7	1462.1	.267	.275	478.2	20.5	40.26	LB	3
Black	217.3	221.4	289.3	728.0	.299	.304	476.0	5.5	22.14	B	3
"	239.0	240.9	305.3	785.2	.304	.307	465.0	3.5	24.09	B	3
Maize	605.9	634.2	424.0	1664.1	.364	.381	575.2	31.8	63.42	M	4
"	580.7	608.1	437.0	1625.8	.357	.374	574.8	28.1	60.81	M	4
"	564.2	594.6	405.8	1564.6	.360	.380	574.4	30.8	59.46	M	4
Green	194.7	249.9	259.4	704.0	.281	.355	508.0	9.5	24.99	G	4
"	153.8	203.6	237.0	594.4	.259	.342	497.0	17.5	20.36	G	4
Sun Tan	367.3	359.2	218.5	945.0	.389	.380	580.5	38.2	35.92	ST	5
" "	347.4	339.6	206.0	893.0	.389	.380	580.5	38.2	33.96	ST	5
Terrapin	240.7	219.5	135.1	595.3	.404	.369	585.6	39.3	21.95	T	5
"	263.2	242.3	157.2	662.7	.399	.365	585.9	36.8	24.23	T	5
Brown	123.5	108.6	50.9	283.0	.436	.384	586.2	51.9	10.86	B	5
"	134.0	112.4	55.5	301.9	.444	.373	589.5	51.2	11.24	B	5
Tangerine	415.0	299.5	71.4	785.9	.528	.382	593.8	76.0	29.95	T	6
"	368.4	259.7	53.2	781.3	.541	.381	594.8	79.2	25.97	T	6
Red	172.5	95.2	32.7	304.9	.566	.312	619.5	67.3	9.52	R	6
"	158.6	87.0	35.9	281.5	.562	.309	622.0	65.3	8.70	R	6
Rose	424.2	338.5	310.5	1073.2	.395	.315	618.0	22.5	33.85	R	7
"	412.2	325.0	289.0	1026.2	.402	.317	615.0	24.8	32.50	R	7
Copen	215.3	219.9	509.8	495.0	.228	.233	477.2	39.2	21.99	C	8
"	196.8	197.2	485.0	879.0	.224	.224	476.2	42.0	19.72	C	8
Navy	350.3	301.4	844.8	1496.5	.234	.201	466.8	42.7	30.14	N	8
"	419.3	360.0	952.4	1731.7	.242	.208	464.8	38.3	36.00	N	8

TABLE I (*Continued*)

Woolen Samples

Sample Designation	Tristimulus Values				Trichromatic Coefficients		Dominant Wavelength in Millimicrons	Excitation Purity in Percent	Brightness in Percent	Figure Number
	$\Sigma xE_cR\Delta\lambda$	$\Sigma \bar{y}E_cR\Delta\lambda$	$\Sigma \bar{z}E_cR\Delta\lambda$	Sum	x	y				
A	208.5	163.3	342.7	714.5	.292	.228	560.2	32.0	16.33	9
"	203.0	163.3	333.8	700.1	.290	.233	560.8	30.0	16.33	9
B	224.0	283.2	403.0	910.2	.246	.311	590.1	24.3	28.32	10
"	229.0	291.6	420.9	941.5	.243	.310	489.8	25.3	29.16	10
C	111.1	62.7	31.1	202.4	.549	.310	621.5	62.2	62.70	11
"	108.8	63.6	31.1	201.0	.542	.316	617.2	61.7	63.60	11
D	19.5	19.0	45.5	84.0	.232	.226	474.9	40.8	19.00	10
"	20.9	20.3	48.6	89.8	.233	.226	474.5	41.0	20.30	10
E	243.3	234.2	201.0	678.5	.359	.345	584.9	20.8	23.42	13
"	237.2	228.2	191.5	656.9	.361	.347	584.4	22.0	22.82	13
F	96.3	65.6	30.7	192.6	.500	.340	603.5	57.2	6.56	12
"	93.2	63.3	29.5	186.0	.501	.340	603.5	57.7	6.33	12
G	148.8	144.8	323.8	617.4	.241	.235	474.5	35.0	14.48	9
"	146.3	144.1	309.7	600.4	.244	.240	474.9	33.0	14.41	9
I	138.6	123.7	101.3	363.6	.382	.340	593.0	25.4	12.37	13
"	135.8	117.2	98.5	351.5	.381	.334	596.0	23.7	11.72	13
J	43.3	48.6	38.4	130.3	.332	.373	565.5	21.1	4.86	13
"	38.7	43.6	32.8	115.1	.337	.379	566.8	23.7	4.36	13
K	37.3	24.8	23.4	85.5	.437	.290	493.4C	34.3	2.48	12
"	40.7	27.4	23.4	91.5	.445	.300	700.0	32.0	2.74	12
L	80.8	79.8	167.0	327.6	.247	.244	473.8	32.0	7.98	10
"	75.2	74.1	159.5	308.8	.244	.240	474.9	43.0	7.41	10
M	150.8	149.8	139.2	439.8	.343	.341	581.6	15.3	14.98	9
"	140.5	140.4	127.6	408.5	.344	.344	580.2	16.8	14.04	9
N	60.8	54.7	83.9	199.4	.305	.274	559.2	16.0	5.47	9
"	67.1	61.1	91.6	219.8	.305	.278	559.8	14.3	6.11	9
O	39.2	35.2	117.5	191.9	.204	.183	473.0	54.9	3.52	10
"	42.4	35.6	130.0	208.0	.208	.171	469.5	55.5	3.56	10
P	61.6	53.9	47.5	163.0	.378	.330	598.2	22.0	5.39	13
"	52.8	45.4	39.6	137.8	.383	.330	599.3	23.2	4.54	13
Q	23.0	25.0	43.6	91.6	.251	.273	481.6	26.5	2.50	10
"	24.2	26.2	46.4	96.8	.250	.271	481.3	27.0	2.62	10
R	27.6	23.6	63.8	115.0	.240	.205	465.0	40.8	2.36	10
"	26.4	22.9	57.3	106.6	.248	.215	463.8	36.3	2.29	10
S	41.1	40.8	43.7	125.6	.327	.325	587.0	6.8	4.08	9
"	39.7	39.4	41.6	120.7	.329	.327	586.0	8.0	3.94	9
T	22.6	33.6	44.1	100.3	.225	.335	493.6	30.2	3.36	10
"	18.2	28.2	37.6	84.0	.217	.335	493.5	31.2	2.82	10
U	22.7	22.0	49.4	94.1	.241	.234	474.0	35.0	2.20	10
"	22.7	21.9	48.3	92.9	.245	.236	473.3	33.5	2.19	10
V	24.0	22.3	30.0	76.3	.315	.292	540.0	12.8	2.23	9
"	25.5	22.7	30.7	78.9	.323	.288	520.0	13.8	2.27	9
W	23.1	21.6	20.7	65.4	.353	.331	592.0	15.4	2.16	9
"	21.9	20.2	18.8	60.9	.360	.332	593.5	17.5	2.02	9

appear to have been dyed with slightly different dyestuffs. The trichromatic coefficients have been found by the method of selected ordinates described in a previous paper [3] to be x = .322 and .320 and y = .307 and .307, respectively,

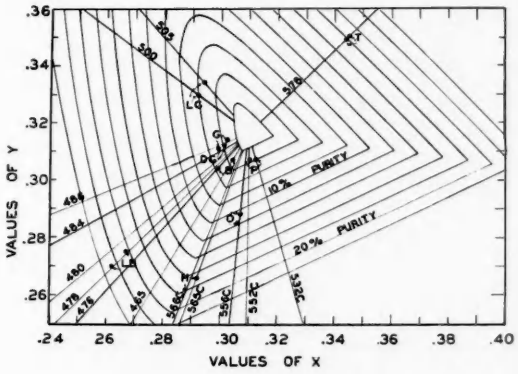

FIG. 3

and are shown plotted in Fig. 3 on an enlarged section of the color diagram. These two points are designated by the letter P and are seen to have complimentary dominant wavelengths of 532C millimicrons and 552C millimicrons, respectively. The excitation purities for these samples are 4.0% and 3.8%. The brightness can not be shown on the color diagram, as this would involve a three-dimensional coordinate system, but is given in Table I.

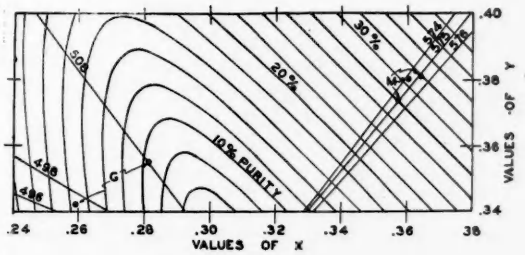

FIG. 4

Numerous other pairs of cotton and wool dyeings are shown in Figs. 3 to 13. Their trichromatic coefficients, as well as the dominant wavelength, purity, and the brightness values, will be found in Table I. Spectrophotometric curves for several representative samples have been given in Figs. 14

to 21. Particular attention is called to Figs. 14, 15, and 16. The colors of the samples were very dark and it was necessary to multiply the value of reflectance by five, which was done by an interchangeable cam in the spectrophotometer. The curves shown here are reproductions of the curves drawn directly by the instrument.

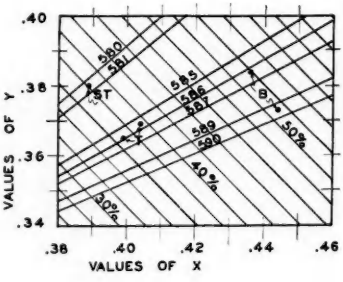

FIG. 5

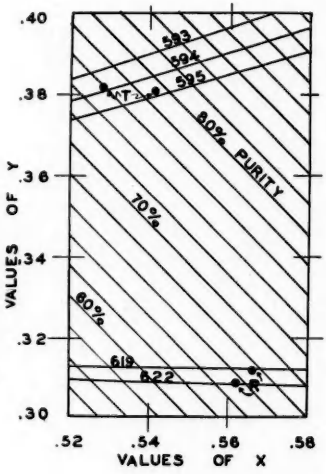

FIG. 6

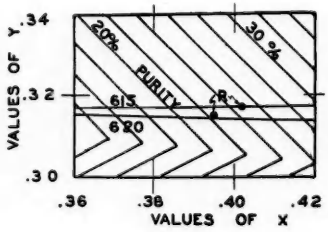

FIG. 7

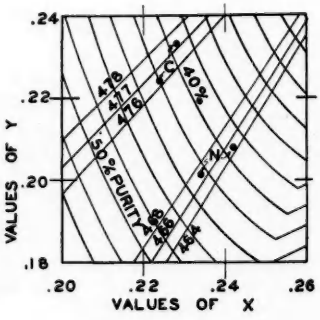

FIG. 8

Matching to a Tolerance Limit

It should be clear from the data presented here that no dyeings are ever matched "exactly." Our experience in other fields should have suggested that such would be the case. It would be useless to tell a machinist to produce

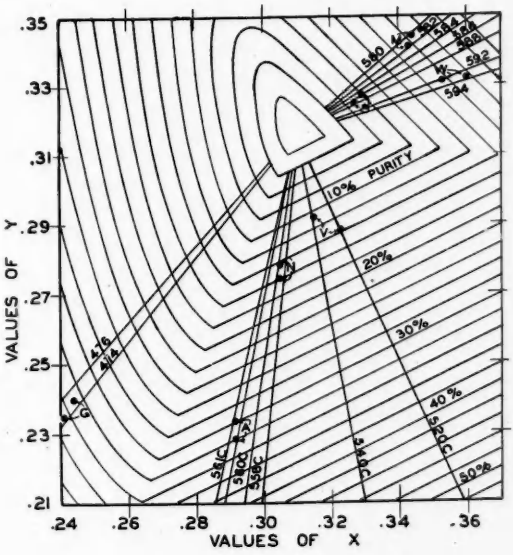

FIG. 9

an object "exactly" like a model. The machinist would immediately demand to know how exactly, or, in other words, to what tolerance he is expected to work. If we tell him "within 1/64 of an inch," he can then match our model with an exactness of detail that is everywhere within 1/64 of an inch of the original. In a similar way it is now possible to guarantee a customer a color match that will be "exact" within a specified tolerance limit.

A specification of this kind should go far to eliminate much of the present dissatisfaction that exists because of the uncertainty with which colors are matched by eye alone. There would be no confusion because the dyer matched his sample in daylight and the customer looked at it under artificial illumination. Tolerance limits would have been determined for a specified type of illumination and there would exist no misunderstanding on this point. The dyer would be protected from unreasonable rejections because, having decided his average tolerance limits for a dyeing procedure, he would be in a position to offer tolerances that he could always be certain of meeting. On the whole, the adoption of such a universal method of specifying color would go far to create a more satisfying situation for the dyer and for his customers everywhere.

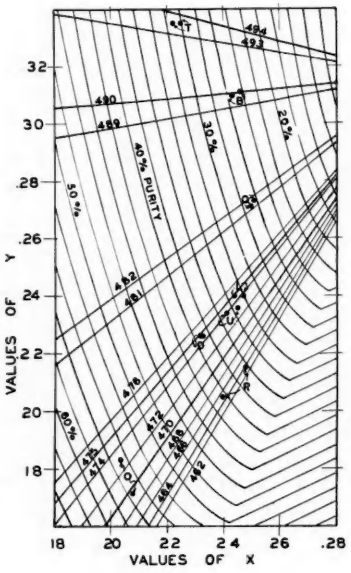

Fig. 10

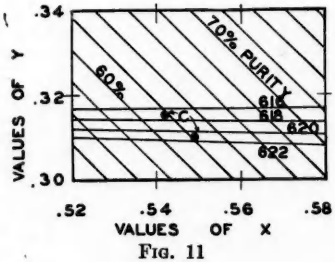

Fig. 11

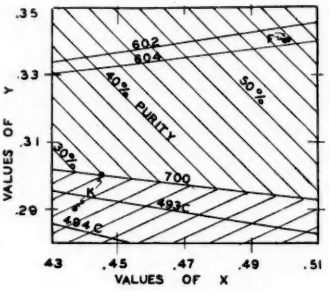

Fig. 12

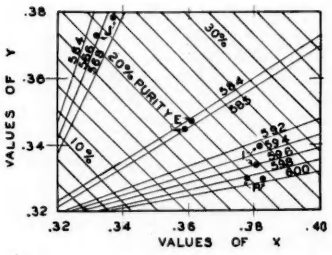

Fig. 13

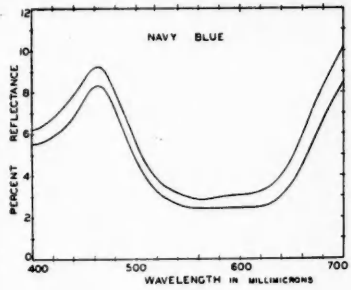

FIG. 14

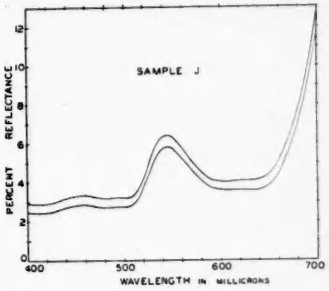

FIG. 15

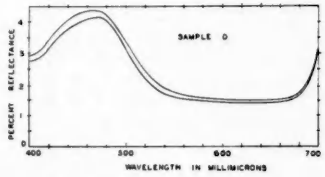

FIG. 16

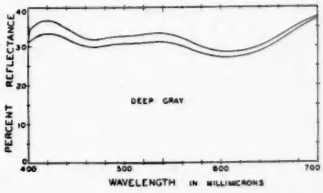

FIG. 17

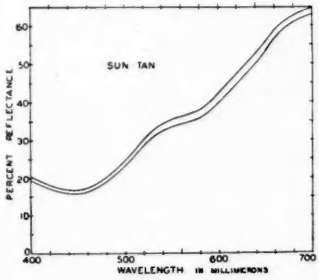

FIG. 18

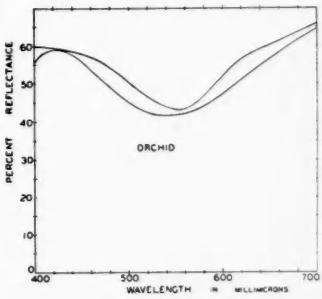

FIG. 19

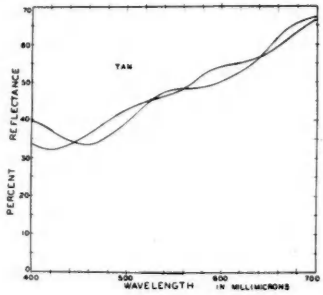

FIG. 20

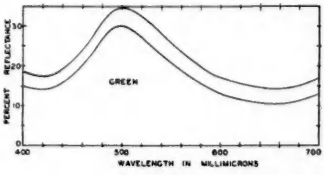

FIG. 21

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"The supreme contribution of science is not in terms of industrial results, though these have probably been indirect consequences. The key to modern civilization and perhaps the most significant step ever made in human progress is to be found in the beginning, about three hundred years ago, of the series of experiments and discoveries which have led, and are now leading very slowly but appreciably, to the substitution of the scientific, rational approach to life for the wholly emotional, superstitious approach that was characteristic of all earlier civilizations and still, alas, is characteristic of the attitudes of great masses of our population." From Address of Dr. Robert A. Millikan to U. S. Institute, Nov. 14, 1935.

Commercial Top Appraisal and Standardization

By ERWIN O. KRUEGEL *

Fellow of the Textile Foundation

Introduction

During the past few years interest has been shown by worsted manufacturers and top makers in a quick, accurate, and convenient method of judging the fineness, staple and strength of a wool top. Many methods have been proposed to determine these important attributes of wool top quality. The methods differ widely as to their practicability, ease of making determinations, and agreement with the results of top appraisers.

The scope of the present series of reports will be to discuss the various methods, their advantages and disadvantages as well as their adaptability to commercial practice. This investigation will be divided into four general classifications:

(*a*) *Fineness*
(*b*) *Staple*
(*c*) *Strength*
(*d*) *Top Standards*

The first three reports of this series will deal with methods for the determination of the attributes of fineness, staple and strength, that have been found to be most reliable in commercial practice. The last of this series will deal with the setting up of a series of top standards for commercial use.

General

DURING the past few years the attention of top makers and worsted manufacturers has been focussed upon the importance of wool top quality standardization and the significance of correct methods by which such assessments might be made. Scientists had worked for many years prior to this, at finding a solution to the problem,[1, 2, 3, 4, 5, 6, 7] but most of them had completely overlooked the commercial practicability of their investigations, so that, to the average merchant, scientific classification of wool top quality attributes appeared as nothing more than interesting academic study.

* Mr. Kruegel is working under the direction of E. R. Schwarz, Associate Professor of Textile Technology, Massachusetts Institute of Technology, Cambridge, Mass.

Since 1928, however, several practical methods for the determination of such of the important attributes of top quality as fineness and staple have been put forth both in this country and abroad. However, before going into a detailed discription of their relative merits and practical value it might be well to digress and discuss the influence of classing, sorting, etc., on the various attributes of top quality and spinning value.

In general, wool sorting plays an important part in the subsequent manufacturing performance of a wool. In order to obtain a level worsted yarn there must be even staple and diameter characteristics in the top as well as good strength, elasticity and surface structure in the individual fibres. It is obvious that the closer a group of fleeces approximate one another in these characteristics, the better will be the manufacturing performance of the lot. Sheep, in general, do not produce wool in any such manner; each fleece carries strikingly different qualities though the environment of the sheep may have been identical. In nearly all cases a fleece will be made up of four or five distinct quality groupings, starting at the shoulders, where the finest wool is found, and gradually increasing in coarseness towards the britch. Yarn, therefore, produced from unsorted fleeces could only be spun to such counts as the coarser fibres would allow, and would be irregular and of poor quality. This must not be interpreted to mean that sorting will give quality where it does not exist. Careful subdivision of the fleeces only makes it possible to spin finer, evener yarns from certain portions of the fleeces than would otherwise be possible.

In recent years the rigid gradation of top has fallen into a decline due, undoubtedly, to the low level of wool prices and to the demand for increased sorting room production. The factor that has allowed this to go on unprotested by the manufacturers is that tops were not spun to their respective limit counts. For example, tops were bought of average fine quality whose limit spin may have been 46s. Yet the manufacturer might have spun this top only to 32s. The top maker, therefore, was in a position to allow coarse wool in his fine blends to pass without any serious objection.

Today, with wool prices again reaching a firmer tone, sorting and rigid top gradation have again come into prominence. These factors, together with the desire by manufacturer and merchant alike to have a better understanding of wool, have brought scientific measurements of top quality attributes to the fore.

Spinning Value vs. Quality

Perhaps the two most widely misused terms in the wool trade are spinning value and quality. While spinning value may be fairly accurately estimated by an experienced spinner, the fact still remains that a spinning frame is the only reliable test for a top's performance. Since this value is dependent on several properties of the fibre, such as length, fineness, surface structure, and serrations, which are all commensurable; as well as elasticity, shrinking ability, torsional strength and natural cohesive tendency, which cannot conveniently be measured, any scientific determination would either be incomplete or would require much more time than the average tradesman could afford to spend. Further, the actual spin of a top is often very different from that estimated, due to processing. There are normally from six to twelve operations from top to yarn, each contributing something to the ultimate result. There is no question but that such extensive processing subjects the fibres to considerable

stress and strain. The degree of efficiency maintained in these processes determines whether or not the spin is impaired or remains the same. Draft, twist, system of spinning, whether French or Bradford, influence the limit spin as do atmospheric conditions and whether the top is in oil or dry. To sum up, the "spinning value" of a top is indicated only by the good yarn obtained from it when spun to limiting count under correct spinning conditions, and cannot be predicted with surety.

The term "quality," on the other hand should be applied as an indication of characteristics such as blend, fineness, staple, strength, color, freedom from neps, vegetable matter, and black fibres. Top makers in general assign top quality values to their product using either of the following criteria as a basis: (1) Fineness, (2) Blends.

A top maker may fix a quality letter such as "C" to his product, representing a wool of 64s "fineness." This top is a 64s or "C" quality whether its average length is 4, 3, or 2 inches. A "C" type of 4-in. average staple may be designated as a "C_1", and that of 2-in. staple as a "C_3"; yet the quality of each is the same.

Other top makers resort to blending different types of matchings in order to produce a top that gives the desired yarn characteristics. Due to irregularities in the supply and prices of raw materials, the same types are not always available for the standard blend. The top maker is then required to produce a top that has the same quality together with the same manufacturing and finishing properties as his standard, although he may use a different combination of types altogether in making his blend.

Characteristics of Quality

Since wool sorting is based primarily on *fineness* of fibre, *staple length*, *strength*, *color*, and *handle*, it would seem likely that these attributes should also be the basis of scientific gradation of top. Crimp, contour, scaliness, plasticity, and many other physical and chemical characteristics of the fibre have been advanced by various investigators [14] as being important to quality. Since it is doubtful whether these characteristics are to the wool sorter more than an additional check on fineness and handle, the conclusion may be drawn that measurements of these characteristics are indicative rather of the top's ultimate spin than of its quality.

If top quality be taken as 100%, then it may be said that fineness of fibre, in conjunction with fibre distribution, staple length and fibre strength contribute perhaps 80%. Color and handle contribute the remaining 20%.

Top Fineness

In order that top may be analyzed for fineness in commercial practice, certain requisites must be fulfilled in the method employed. First, the attribute of fineness must be determined with reasonable speed. Top appraisers rarely require more than one-half hour to evaluate a top's quality against a standard. Secondly, both the method and technique must be relatively simple. Third, the final result must be representative of those factors which the appraiser deems important to fineness.

The fineness of wool top may be expressed as (*a*) weight per unit length, (*b*) cross-sectional area, or (*c*) diameter. Winson,[8] in his analysis of selected British tops, used the weight-per-unit-length method. From several places

along the top small samples were taken between the thumb and finger and separated from the top. The resulting bundle was placed in an instrument designed for cutting the fibre to a fixed length. The length to which the fibres are cut must not be greater than the length of the shortest fibre in the top, otherwise these would contribute nothing to the mean fineness. There is, however, no point in cutting the fibres shorter than this value, since it increases the number of fibres necessary to give a weight ascertainable with the desired accuracy.

From this bundle were counted out a definite number of fibres. The counted groups were rolled together by the fingers into compact bundles and washed in warm benzene, followed by two rinsings in distilled water. These bundles, together with a pilot sample, were exposed in the same room and were allowed to dry. The counted groups were then carefully placed in weighing bottles, and the larger sample in a regain bottle, and their weights determined on a sensitive chemical balance. The bone-dry weight of the sample in the regain bottle was then found by regular laboratory methods. The corresponding dry weight of the counted bundles could then be found by simple proportion. The mean fibre fineness is then obtainable and is expressed in terms of the weight of 10 meters of fibre at 18¼% regain.

S. G. Barker and Winson,[9] found that if equal intervals are assumed between the various qualities a linear relationship then exists between the logarithm of the fineness expressed as the weight of 10 meters of fibre and its position in the scale of qualities. Mathematical treatment of these data leads to a relation expressed by the equation:

$$X = 14.79 \log \left(\frac{W}{L}\right) - 6.58$$

S. G. Barker states that this equation is very useful, in that "once the mean fineness of a top is known its position on the English scale of standards may be readily obtained." But the appraisal of a top for the fineness attribute of quality is never based on an average fibre fineness, but rather on the amount of fine, average and coarse fibre that is present. For each quality there is a limit to the finest fibre as well as to the coarsest that can normally exist in that particular quality. For example, a top blend made up of 50% by weight of standard 70s Quality and 50% by weight of standard 60s Quality had an average fibre diameter of 22.0 microns.* The limit of coarseness of the blend was 40 microns. The standard 64s quality had an average diameter of 22.0 microns, but its limit of coarseness was 35 microns. Both of these tops were identical so far as average fineness is concerned, yet the blend had a coarser "edge" than the standard 64s top. From this it is obvious that fineness cannot be expressed by an average value alone, but must be substantiated by the amounts of fibre ranging from the finest to the coarsest in the total array that produced this average.

Hardy [10] made a series of measurements on U. S. Standard wool and top samples by means of a special cross-section plate. The size of the sample to be placed in the cross-sectioning plate was determined by a "fineness" device.[10a] The area of the space holding the cross-section was 0.25344 square mm. In order to facilitate counting the fibres an ocular was used in which there was a celluloid disc with three holes arranged in a straight line. Each of these holes covered 12.4% of the area in which the cross-section is held.

* One micron is equivalent to 0.001 millimeter.

The number of fibres in each of these three holes was counted. The average of the three readings represents a "fineness number" of the wool.

TABLE I

Wool Samples	64s	58s	56s	48s	46s	44s	36s
No. in Circle	56.8	45.7	40.7	26.5	24.0	19.7	18.0
Top							
No. in Circle	53.0	43.0	36.3	26.7	23.7	21.0	17.3

In a later paper, Hardy [11] describes an improved cross-section plate and the measurement of cross-sectional diameters as a fineness criterion. A small sample of wool was sectioned. The cross-section plate was placed on the stage of a projection microscope and the cross-section focussed on a sheet of white paper. A magnification of 500 diameters was used. The projected images of the cross-sections may then be measured as projected, or may be photographed and measured. By using a paper wedge, described by Lauth [12] and von Bergen,[13] the average diameter as well as the frequency distribution can be readily determined.

Perhaps the method that has received the most favorable acceptance in the trade is a modified form of the one described by Lauth and later by von Bergen. It consists of drawing a random sample from the top. This sample is then mounted on a glass slide and placed on the stage of a projection microscope. The fibre diameters are then measured by means of a "wedge" properly calibrated. From this wedge it is a simple matter to determine the fineness distribution and average fineness of the top.

It is obvious that the weight-per-unit-length method necessitates careful parallelization of the fibres under fairly even tension, cutting to a definite length, counting, and then washing, drying and weighing under controlled conditions. Because of this rather lengthy and exacting preparatory technique, the method is hardly adaptable to commercial practice. Aside from the objectionable time feature, this method, as stated before, renders no data as to the distribution of the fibres; a factor that is vitally necessary in the assessment of a top's fineness.

It is a well known fact that the contour of wool fibres varies from circular to ellliptical, depending on the type of sheep, the trueness to type, selection of the flock and its environment. If, therefore, direct measurements were made of the diameter of the fibre in a longitudinal mount, the larger diameter would always be measured. This is so because fibres, elliptical in shape, mounted in a mounting medium, will arrange themselves so that the maximum cross-section axis is parallel to the slide. In order to overcome this "error" the cross-sectional method has been suggested. By this method the major and minor axes can be measured. Then the geometric average (equal to $\sqrt{\text{major} \times \text{minor}}$) would represent the fibre diameter at that point.

Investigation has indicated that circularity may be, in some way, related to spinning value. S. G. Barker and Burgess,[15] Sidey,[16] and others have shown that low circularity ratios and good spinning qualities are, in some way, related. Sidey made a series of tests on Romney and Corriedale fleeces, and found that wool judged by the trade as being good average and fair for spinning quality had the following ratios:

TABLE II

	Romney	Corriedale
I Good, according to trade opinion	1.157	1.199
II Medium, according to trade opinion	1.210	1.210
III Fair, according to trade opinion	1.245	1.224

It has therefore been suggested that the ratios of the major to minor axes of the sections cut by the rapid sectioning method can give additional information as to the "roundness" of the wool. This information, obtained by any such method, would be helpful in assessing spinning value for commercial practice. But it is rather doubtful whether or not the sections cut by a rapid sectioning method are representative of the true section shapes for the following reasons:

(*a*) To cut a true section, the long axes of the fibre or bundle of fibres to be cut must be perpendicular to the cutting plane. Since the wool fibre exhibits an undulated waviness called "crimp" and in some cases a twist along its length as well, it is rather improbable that a group of fibres will arrange themselves in a plate so that their long axes are perpendicular to the cutting plane. Instead of arranging themselves as in Fig. 1, it is more likely that the arrangement will be as shown in Fig. 2.

Fig. 1 Fig. 2

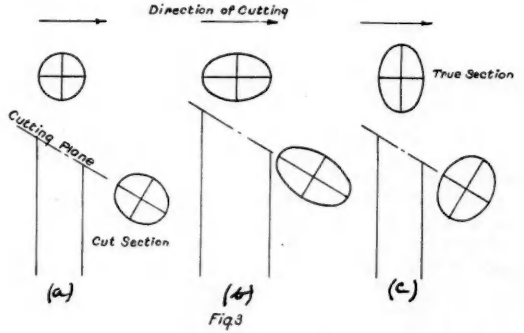
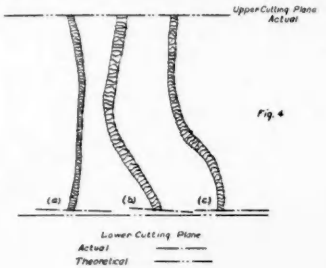
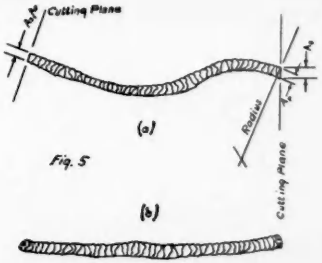


Fig. 3

(*b*) This fact is further substantiated by the uneven intensities in illumination of the fibre sections under the microscope. In order that a fibre section may be illuminated by transmitted light, the light must travel parallel to the





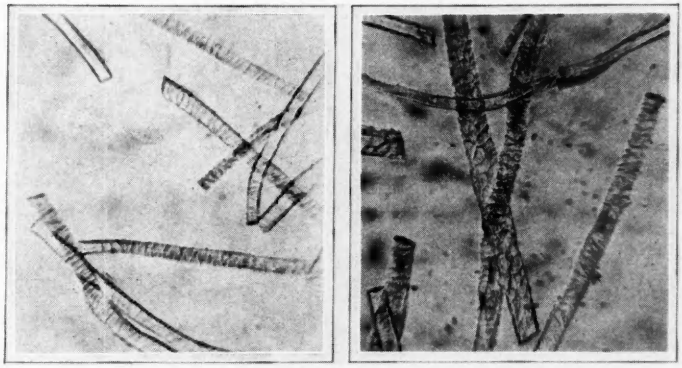


FIG. 6. (Left.—70s Wool. Right.—50s Wool)

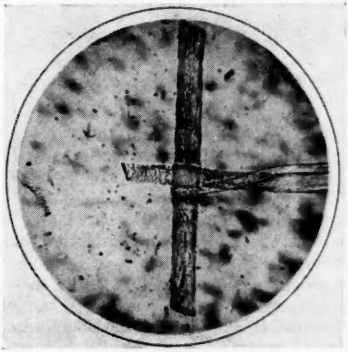


FIG. 7

long axis of the fibre. If the long axis of a fibre in a sectioning plate is curved, the light, tending to travel in a straight line, will leave the fibre and be lost. Such a fibre will then appear darker than one whose axis is parallel to the direction of illumination. For example, should the arrangement of the fibres in a plate be as (*a*), (*b*), and (*c*) in Fig. 4, fibre (*a*) would appear brighter than either (*b*) or (*c*).

(*c*) The examination of fibres removed from a cross-section and placed in a longitudinal mount revealed that the angle between the section planes

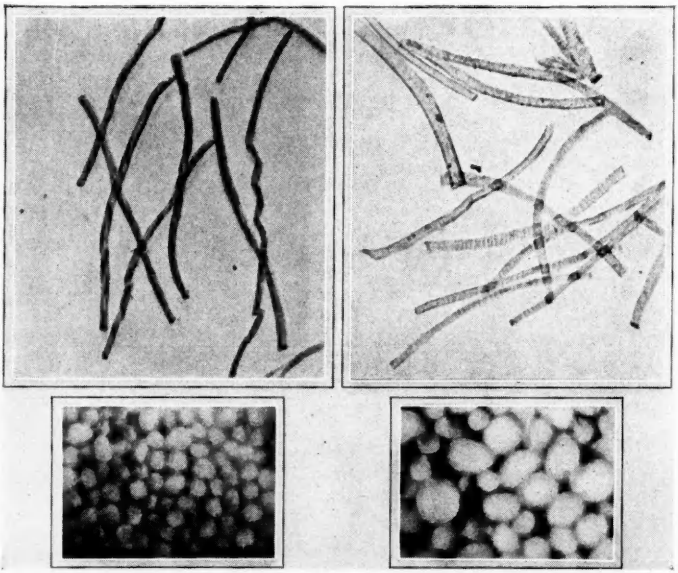


FIG. 8. 70s Wool.

FIG. 9. 50s Wool.

and the long axis of the fibres varied from 0 to 35° (see Fig. 6). It is obvious that for this to occur, the angle between the long axis of the fibres and the cutting plane in the section plate before cutting, must also have varied from 0 to 35 degrees. This variation in the section angle is caused, (1) by the natural crimp as in the fibre Fig. 4(*b*); (2) if the fibre is straight, by the inclination of the fibre as shown in Fig. 4(*a*). An actual photomicrograph of this latter case is shown in Fig. 7.

With an arrangement as shown in Fig. 2, the sections would vary from circular to elliptical depending on the position of the long axes of the fibres relative to the cutting plane, even though the fibres were all perfect cylinders. On the other hand, if the fibres are elliptical it is possible for the section to approximate a circle as in Fig. 3(*c*).

Since this is an observed fact, it remains to be seen to what percentage the cutting angle influences the "Deviation from Circular."

A series of cross-sectional measurements were made on a 56s domestic top. The sections were cut by the metal plate method, and were traced on a sheet of paper by the use of a projection microscope. From these tracings of the sections the major and minor axes could be found. Table III is illustrative of the results.

TABLE III

Sample No.	A	B	Dev. from Circular A−B	Ratio $\frac{A}{B}$
1	0.396	0.312	0.084	1.27
2	0.387	0.323	0.064	1.20
3	0.330	0.249	0.081	1.33
	Average		0.076	1.27

The cross-sections were removed from the plate and were mounted longitudinally in glycerine. Under the projection microscope the fibres appeared oriented from a position indicated by fibre (*a*) Fig. 5 through 90° to one as shown by fibre (*b*) Fig. 5. In order that a true relation between the normal diameter A_p and the sloped diameter A_s could be found, only such fibres whose orientation was as indicated by fibre (*a*) Fig. 5, were taken into consideration. Table IV shows the results of these measurements.

TABLE IV

Sample No.	A_s	A_p	$A_s - A_p$
1	0.343	0.317	0.026
2	0.316	0.270	0.046
3	0.344	0.304	0.40
		Average	0.037

Deviation from circular (Due to cutting) 0.037
Deviation from circular (Sections) 0.076
% of deviation from circular, due to angle of cutting 48.3%

If 48% of the deviation from circular of a group of fibres is attributable to the cutting angle over which there is little or no control, it seems probable that data from such measurements are of little or no value.

Wedge Dimensions

From an optical point of view the extreme practical limit of magnification of a projection microscope using an 8-mm. objective (N.A. = 0.5) and a 12.5 × ocular is 500 ×. Experience has shown that at this magnification the diffraction-band effect cannot be eliminated. With this effect present, the tendency is for the observer to measure the diameter too small (see Fig. 10). As a result, the data, while comparable to other data from the same projector, will not agree with data taken from a projector in which the effect is not present.

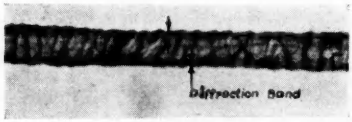


FIG. 10

Various lower magnifications have been tried, and 250 × was found to be the magnification best suited for this work with the above mentioned lens system. Higher magnification is obtainable without diffraction if an objective of higher numerical aperture is used. This would have to be a 4-mm. lens. While 500 × would then be allowable, the depth of focus would be so reduced as to make the investigation difficult, particularly when traversing a fibre. Since the working distance is very small, difficulty will be experienced in avoiding damage to the slide and objective.

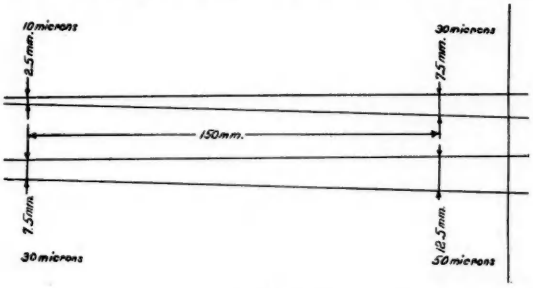


FIG. 11

Practical experience over a period of years with a large number of observers has proven that a wedge of the dimensions shown in Fig. 11 is suitable for commercial top-fineness determinations. The dimensions have been made such that the personal equation errors, arising from any measurement of this nature, are reduced to a minimum.

Aside from the fact that the wedge method is relatively simple and quick, it has the advantage that no scale readings are necessary. Once the wedge

has been calibrated against a stage micrometer no further calibration or settings are necessary.

Technique of Drawing Sample

Perhaps the most important factor in top-fineness determinations is that of drawing the sample. The importance of technique and the carrying out of this technique with great care, cannot be stressed too much. Serious errors may result if the samples are drawn in a hasty manner.

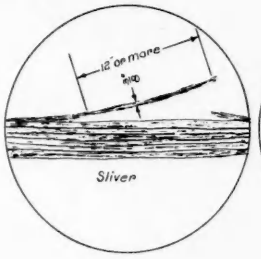


FIG. 12

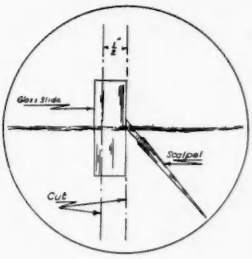
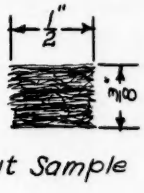


FIG. 13

From the top, separate a strand of fibres approximately ⅜-in. in diameter and a foot or more in length. (Fig. 12.) From this strand cut with a razor blade a small section approximately ½-in. long. (Figs. 13 and 14.) Clamp one end of this fibre tuft with a clamp similar to that used with a Baer stapling



Cut Sample

FIG. 14

device and draw the fibres through a fine comb using a wavy motion. (Fig. 15.) This motion is necessary to prevent the fibres from being broken. The combing operation will take out all the fibres that are less than the normal cut length. The tuft is then clamped at the other end and drawn through the comb again. The fibres should now be parallel and free from all fibres cut less than the required length. By placing a glass slide over the fibres, exposing about ⅛-in. (Fig. 16), it is possible with the eraser-end of a pencil to reduce the tuft to a width of about ¼-in. Place a drop of glycerine on a glass slide and mount the fibres. If the technique has been carried out correctly the fibres should be arranged similar to those in Fig. 17. Should the fibres be packed too closely together, or lie in a criss-cross fashion, it

might be well to make a new mount, spreading the fibres more. A little practice will show just what degree of spreading is necessary to produce a good mount.

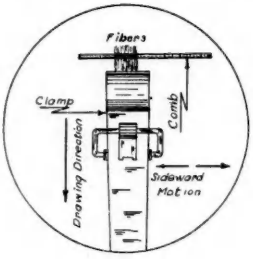


FIG. 15

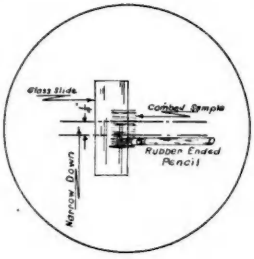


FIG. 16

Wedge Analysis

The slide should be properly placed on the stage of the projection microscope. Move the slide by means of the mechanical stage until the extreme right- or left-hand edge of the slide is projected on the horziontal screen.

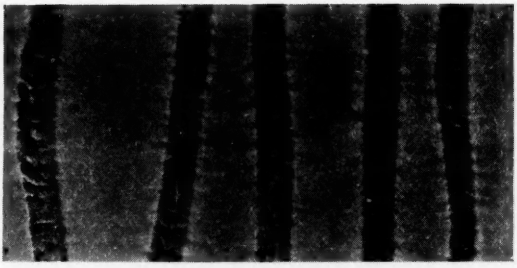


FIG. 17

Disregarding the first few fibres from the edge, bring a fibre into sharp focus. Move the wedge along the axis of the fibre until the inclined lines on the wedge are tangent with the fibre. Mark this point by a small line. (Fig. 18.) Bring the next fibre into focus and proceed as before. Continue this process, taking one fibre after another until a sufficient number of fibres have been measured.

FIG. 18

FIG. 19

It may happen, and this is more likely in coarse wools than in fine, that the fibres are not always uniform in diameter. (Fig. 19.) An arbitrary method for measuring such fibres has been to traverse the fibre by means of the mechanical stage, note the diameter variation and then choose a point ("*a*" in Fig. 19) that appears to be a mean value between the greatest and least diameter. Another method is to make two measurements, one at the greatest diameter ("*b*" in Fig. 19) and one at the least ("*c*" in Fig. 19).

TABLE V

Class Interval	Number of Fibers (f)	Appr. Av. Dia.	Assigned Values (x)	Sum of fx minus	Sum of fx Plus		x^2	Σfx^2
10 - 11	0		-8					
11 - 12	0		-7					
12 - 13	1		-6	6			36	36
13 - 14	3		-5	15			25	75
14 - 15	9		-4	36			16	144
15 - 16	6		-3	18			9	54
16 - 17	11		-2	22			4	44
17 - 18	7		-1	7			1	7
18 - 19	12	18.5	0	-104			0	0
19 - 20	13		+1		13		1	13
20 - 21	14		+2		28		4	56
21 - 22	10		+3		30		9	90
22 - 23	4		+4		16		16	64
23 - 24	5		+5		25		25	125
24 - 25	3		+6		18		36	108
25 - 26	0		+7		0		49	0
26 - 27	2		+8		16		64	128
27 - 28	0				+146			944

$$\sigma = \sqrt{\frac{\Sigma fx^2}{N} - c^2}$$

Σfx +146
Σfx -104
$\Delta \Sigma fx$ +42

$$\frac{\Sigma fx^2}{N} \quad \frac{944}{100} = 9.44$$

$$c^2 = \frac{0.17}{9.27}$$

$$c = \frac{\Delta \Sigma fx}{N} = \frac{+42}{100} = +0.42$$

$$\sigma = \sqrt{9.27} = 3.0$$

Aver. Diam. = 18.5 + 0.4 = 18.9 μ

$$\sigma_{\bar{x}} = \text{Std. Error} = \frac{\sigma}{\sqrt{N}} = \frac{3.0}{\sqrt{100}} = 0.30$$

Dispersion = Av. Diam ± 3σ 9.9 - 27.9 μ

Diam. Range = Av. Diam ± 3 S.E. = 18.0 - 19.8 μ

Arithmetic Mean Diameter

The arithmetic mean of a series of measurements is the sum of the individual measurements of the variable divided by the number of them and is a true average. Expressed algebraically it is

$$\bar{x} = \frac{\Sigma x}{N}$$

where $\bar{x}$ = the mean or "average" value

Σx = the sum of the individual measurements x_1, x_2, x_3, x_n

and N = the total number of items.

However, when there are a large number of items, it is easier to group them into a frequency table so that f_1 represents the frequency or number of x_1 values, f_2 the number of x_2 values, etc. The arithmetic mean can then be found by multiplying the midpoint value of each class grouping by the frequency or number of items assigned to that class; for example, if x_1 = the lower boundary of the class, x_2 = the upper boundary of the class, and f = the frequency or number of items falling in that class, then

$$f\left(\frac{x_1 + x_2}{2}\right) = \text{the contributing factor of that class interval to the mean.}$$

The sum of these products divided by the total number of items equals the arithmetic mean. It is obvious that the calculation of the mean by this method is not suitable for quick and accurate work, so that a so-called "short method" has come into use.

A property of the arithmetic mean is that the sum of the deviations from the arithmetic mean is zero. Expressed algebraically this resolves itself into the following:

Let $\bar{x}$ = arithmetic mean

x = value of the midpoint of a given class interval

f = the frequency in the class

N = total frequency

Then, $\Sigma f(x - \bar{x})$ = the sum of the deviations from the mean, also $\Sigma f(x - \bar{x}) = \Sigma fx - \Sigma f\bar{x} = Nx - N\bar{x} = 0$. This resolves itself arithmetically in a simple case into the data of Table VI.

TABLE VI

	Items	Deviations from Average	
		+	−
(1)	3		− 2
(2)	4		− 1
(3)	6	+ 1	
(4)	7	+ 2	
(5)	5	+ 0	
	5	+ 3	− 3

Sum of Deviations, + 3 − 3 = 0

Let us suppose that the midpoint of a class is assumed to be the arithmetic mean and that the deviations are measured from it. Then it follows that the algebraic sum of the deviations divided by the number of items is the average deviation of the assumed mean. The addition of this average deviation to the assumed mean will give the actual mean.

For example,

Let x_a = the assumed mean

x' = value of the deviation measured from the assumed mean

then $fx' = f(x - x_a)$ is the deviation of items in that class from the assumed mean

and $\Sigma fx' = \Sigma fx - \Sigma fx_a$ = the total deviation

$= \Sigma fx - \Sigma fx_a = N\bar{x} - Nx_a$

simplifying $\bar{x} = x_a + \dfrac{\Sigma fx'}{N}$.

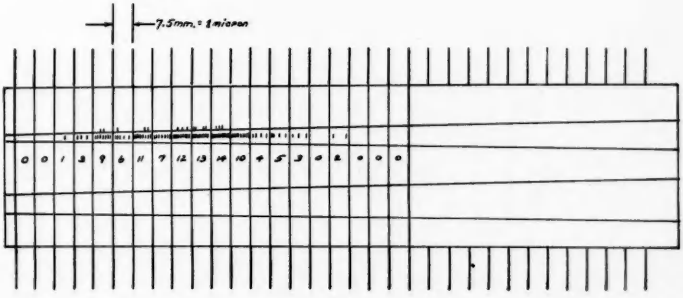


FIG. 20

Referring to Fig. 20, in order to find the average fibre diameter, first superimpose the wedge on a ruled scale and divide the wedge into one micron divisions. The scale to which this ruled scale is drawn is such that one division equals 7.5 mm. This corresponds to one micron on the wedge. Count the number of fibres falling into each one-micron division. (Column 2, Table V). Estimate approximately the class interval into which the mean or average diameter is likely to fall. Assuming the midpoint of the chosen class to be the mean value, assign values of + 1, + 2, + 3, etc., to increasing micron divisions, (Column 4) and values of − 1, − 2, − 3, etc., to the decreasing divisions. Multiply the number of fibres (f) in each interval by the assigned value. For example,

Let $\pm x$ = the numbers assigned to a class interval

f = the number of fibres in each class

then $\pm fx$ = the deviations.

Add all the plus products ($+ \Sigma fx$) and all the minus products ($- \Sigma fx$). Obtain the algebraic sum of these quantities and divide by the total frequency "N." This resulting value, added algebraically to the assumed mean, will give the actual mean.

Standard Deviation

Before discussing standard deviation and its significance in top-fineness measurements, let us examine how the wool sorter determines his quality limits. In sorting for a quality the wool sorter sets up a limit as to the finest and coarsest group of fibres that can normally go into the makeup of that quality. Further, the wool sorter will always associate the same range of fineness with that quality no matter when, or from what fleeces, the sort may be made. Therefore, the range, or dispersion of the fineness attribute of a group of matchings of a quality, will be substantially the same. Also, in a lot of matchings there will be groups of fibres that have the same diameter. Any one fibre chosen from a top at random is representative of a group of fibres of substantially the same diameter. The arithmetic mean, therefore, of a top-fineness determination is the average value of a series of representative averages. Since the dispersion factor for the fineness of a quality as set up by the sorter is almost constant, any series of measurements on that quality should also have a constant dispersion factor. (See Table VIII.) This dispersion factor for a series of measurements, treated statistically, is called the standard deviation.

The standard deviation then is a measure of how much the values of the distribution vary from some central value. Also the standard deviation * is a measure of the probability with which individual readings will fall within a range. The probability of values falling within the following ranges from the arithmetic mean is noted in Table VII.

TABLE VII

Within Range from Arithmetic Mean	Probability
$-\sigma$ to $+\sigma$	68.3%
-2σ to $+2\sigma$	95.5%
$+3\sigma$ to $+3\sigma$	99.7%

This simply means that, if a range is established equal to $\pm 3\sigma$ from the arithmetic mean, the chances are then that only 3 out of every 1000 readings taken from the same sample or similar sample will fall outside this range. Table VIII is an illustration of the variation in the standard deviation of samples of the same type.

TABLE VIII

60s Top from Trapped Fleeces

		σ (microns)	Range $\pm 3\sigma$ (microns)
40 tops (total of 8000 observations)		5.7	8.0–42.0
1 top (total of 100 observations)	A	5.9	7.0 42.0
	B	5.5	9.0 42.0
	C	5.1	10.0 40.0
	D	5.3	10.0 42.0
	E	5.6	8.0 41.0

* This value is usually denoted by the symbol σ.

A formula for computing the standard deviation is

$$\sigma = \sqrt{\frac{\Sigma fx^2}{N} - c^2}$$

where f = the frequency
x = assigned deviations
N = the total frequency
c = the difference between the assumed mean and the actual mean.

Using the short method (see Table V),

(1) Square the assigned values of + 1, + 2, − 1, − 2, etc., and multiply these by the frequency of their respective groups.
(2) Add these products and divide by the total frequency.
(3) Subtract algebraically the value of "c^2."
(4) The square-root of the difference will be the standard deviation.

Standard Error

It can be proved, according to the theory of probability, that an exact relationship exists between the standard deviation of the curve of arithmetic means, the standard deviation of the universe,* and the number of samples. This relation is expressed by

$$\sigma_m = \frac{\sigma_\mu}{\sqrt{N}}$$

where σ_m = the standard deviation of the sample
σ_μ = the standard deviation of the universe
N = the total number of samples.

Since it is impossible to determine the standard deviation of the universe, σ_μ, the standard deviation of the sample is used in its place. The equation then becomes

$$\sigma_m = \frac{\sigma s}{\sqrt{N}} \dagger$$

In order for this relationship to hold, the assumption must be made that the mean of the sample is a true mean. The error in this assumption can be controlled by taking a sufficiently large sample. This deviation of the mean is called the standard error.

TABLE IX

Range of S.E. or σ_m	Approximate Probability inside
$\pm$ 1.0 σ_m	68%
$\pm$ 2.0 σ_m	95%
$\pm$ 2.5 σ_m	99%
$\pm$ 3.0 σ_m	99.7%

* The universe refers to all the wool of a particular quality in existence.

† If the number of items N is less than 30, the formula is $\sigma_m = \frac{\sigma s}{\sqrt{N-1}}$. Over 30, the formula becomes $\sigma_m = \frac{\sigma s}{\sqrt{N}}$. This is so because if N is large the $\sqrt{N-1}$ and $\sqrt{N}$ are very nearly the same.

Referring to Table IX, if a range of diameter of $\pm 3\,\sigma_m$ is taken in a quality determination, then it follows that approximately 99.7% of the means of similar groups of observations will fall within this range.

Frequency Distribution

If the diameters from a series of measurements are arranged according to magnitude, with the smallest first and the largest last, the arrangement is called an array. Thus the wedge having a number of measurements on it (Fig. 20) is an array. The difference between the largest and smallest value in the array is called the range. It would, however, be difficult to form an opinion as to the amounts of fine, average and coarse fibre present from an array. By grouping together those readings whose diameter values lie within certain limits or class intervals, the make-up of the top becomes more apparent.

From a practical point of view the class interval for top-fineness frequency should be of such a magnitude as to show differences in similar tops if they exist, and yet not to lose the general characteristics that are typical of the quality. Experiment has shown that if the class interval is too small, irregular polygons will be the result. (Fig. 21.) Since the polygon based on a small

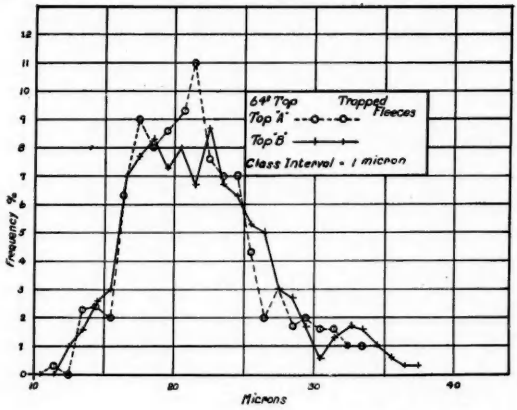


FIG. 21

interval varies greatly unless the number of observations is increased beyond practical limits, it is difficult to say which of a series of tops of the same quality is the best for fineness.

On the other hand, if the class interval is made too large the result will be a loss of fineness differentiation.

The curves in Fig. 21 illustrate the frequency polygon of two tops of 64s quality with a one-micron class interval. Those in Fig. 22 show the same tops with a 10-micron interval. From these curves it is obvious that in one case the variation is such that no opinion can be drawn as to the relative difference in

the make-up of the tops. In the latter case (Fig. 22) the variation from group to group has been reduced, but the consolidation has been carried to a point where it is impossible to detect if differences exist. To determine what class

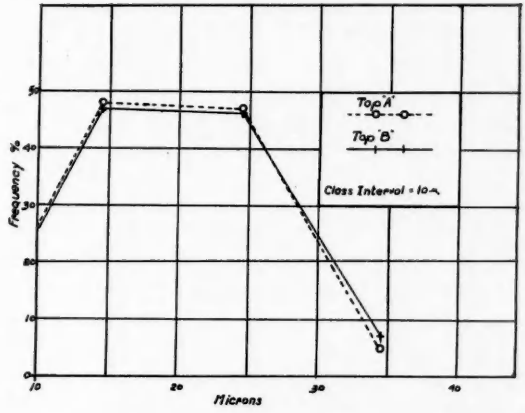


FIG. 22

interval expressed the desired results, a large amount of data collected over a period of years was plotted at various micron intervals from 1 to 10. The top from which this data was taken was submitted to a group of expert top appraisers. The opinions of these experts were then compared with the frequency polygon of various class intervals. Thus it was found empirically that an in-

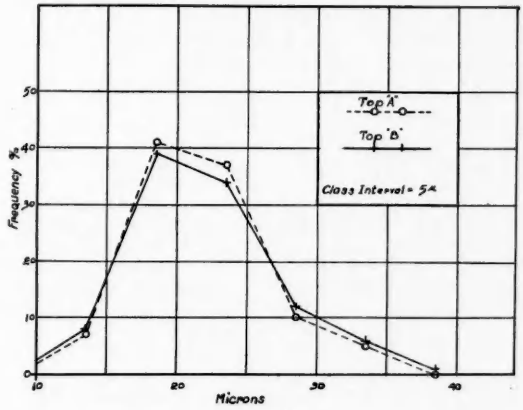


FIG. 23

terval of 5-microns (Fig. 23) was sufficiently large to give a smooth polygon and yet be sensitive enough to detect differences if they exist. Table X illustrates the frequency groups.

TABLE X

Group	Class Interval Groups (Microns)
I	6.5–10.5
II	11.5–15.5
III	16.5–20.5
IV	21.5–25.5
V	26.5–30.5
VI	31.5–35.5
VII	36.5–40.5
VIII	41.5–45.5
IX	46.5–50.5
X	51.5–55.5

Conclusion

Many top makers and worsted manufacturers have undertaken the standardization of their respective types of top by means of the wedge method.

For each of three consecutive years 10 tops are usually taken that are, in the opinion of their appraisers, representative of the type to be standardized. For each top 200 fibres are measured. By plotting the frequency polygon for the average of each of the three 10-top groups, it is possible to study the trend of the type over this period. The diagrams in Fig. 25 show such a series. If the diagrams are in good agreement, the indication is that the type does not vary from year to year and that it can be standardized. For each of the one-year groups the average diameter, standard deviation, and standard error are found. From these data it is possible to find the dispersion of the type, and the probable range within which the true mean is likely to fall. This information will further substantiate the value of the frequency polygon as a guide to the determination of uniformity and trueness to type which the tops in question exhibit. In short, it is necessary to investigate, over a period of several years, a type to be standardized, in order to get the following information:

(*a*) Is the dispersion of the type a constant?
(*b*) Do the blending of different kinds of wool in a type change its diameter characteristics?

The standard of the type is then determined from the total fibres examined over this three-year period. The average diameter standard deviation, and standard error are then found. From these data the dispersion for the three-year period can be determined, as well as the diameter range. From the theory of probability, a diameter range from the mean of plus or minus 3 times the standard error indicates that only three averages in a thousand will fall outside this range. But this range is *only valid for the average of another 6000 fibres.* It is obvious that in a commercial appraisal a sample of this size would be out of the question. Fortunately, the difference in average diameter of two successive qualities is such that no overlap occurs for the upper limit

of the diameter of one quality and the lower limit of the next quality in commercial top. For example, the average commercial type 64s quality has an average diameter of 22.0 microns, and a range of 21.8–22.2 microns for 6000 fibres. The 60s quality has an average of 25.1 microns and a range of 24.9–25.3 microns. Further, the trade agrees that a low grade of one quality is equivalent to a high grade in the next lower quality. For example, a low 64s quality is equivalent to a high 60s. This, of course, applies to *fineness* only. It is therefore possible to reduce the number of fibres needed for an appraisal until the upper value of one quality, as determined by adding $3\sigma_m$ to the mean, equals the lower limit of the next lower quality determined by subtracting $3\sigma_m$ from its mean. (Refer to Table XI.)

TABLE XI

Quality	Average Dia. Microns	σ	σ_m	Range
64s	22.0	4.6	0.06	21.8–22.2
60s	25.1	5.7	0.07	24.9–25.3

The difference between the larger diameter of the range for 64s quality and the smaller diameter of the range for 60s quality may be expressed: $24.9 - 22.2 = 2.7$ microns. (See Table XI.)

Since each quality is to contribute equally to this difference in order to bridge the gap, each will have to contribute $\frac{2.7}{2}$ or 1.4 microns.

TABLE XII

64s Quality			60s Quality		
No. of Fibres	σ_m *	$3\sigma_m$	No. of Fibres	σ_m †	$3\sigma_m$
100	0.46	1.3	100	0.57	1.7
200	0.31	0.9	200	0.40	1.2
300	0.27	0.8	300	0.33	1.0
400	0.23	0.7	400	0.29	0.9

* σ = constant = 4.6. † σ = constant = 5.7.

From Table XII it will be seen that three-times the standard error for 100 fibres is equal to 1.3-, or very near to the required 1.4-microns. Thus, the 100 fibres which gave this value will be an adequate sample.

On the other hand, inspection of Table XII shows that a sample of 200 fibres of 60s quality gives 1.2, which is very nearly the required amount of 1.4. Experience has shown that, although 100 fibres can be considered sufficient to compare a type with the standard for a 64s quality type, this number is not enough to give the desired frequency-grouping results. A similar procedure was carried through for the number of fibres required to give good frequency characteristics. In Table XIII the minimum number of fibres required for an appraisal is given.

TABLE XIII

Type	Minimum number of fibres
80s–70s	200
64s–62s	300
60s–58s	400
56s–50s	500
Lower than 48s	800–1500 depending on the dispersion of the type. If the standard deviation is greater than 12, 1500 fibres are necessary.

Commercial Standards

Top-quality standardization has been a topic of discussion for a number of years. Attempts have been made, both in this country and abroad, to reach some common international standard with which top from all countries can be compared. This, however, is difficult because of two important factors: first, manufacturing requirements in each country are different, due to prices of grease wool, cost of labor, and types of wool normally grown in that country. Second, in commercial practice qualities are governed by the manufacturing and finishing properties which the wool is to give to the final product.

Let us illustrate the first point. This country has a relatively high cost of labor. The finished product, however, must be produced to meet a certain price level so as to meet competition. Careful sorting has, therefore, in the majority of cases given way to trapping. Now this procedure introduces

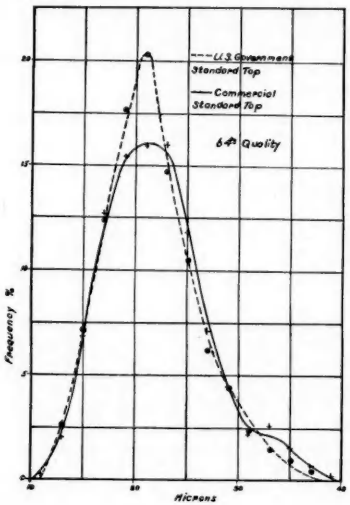


FIG. 24

characteristics into a top that cannot be evaluated by comparison with tops from carefully sorted fleeces. To illustrate this point further, Fig. 24 shows the frequency-diagrams or "make-up" diagram of the U. S. Government 64s Standard, as compared with an average of a series of commercial 64s tops, representing approximately 80% of the total top of this type used in the United States. Note that in the U. S. Standard a large percentage of the fibres lies in a small diameter range. This indicates the influence of extreme care in sorting. The fibres were sorted to a close limit. Also, the diagram is almost symmetrical, denoting a uniform gradation from the fine to the coarse fibres in the make-up of this top. The average "commercial top-standard" has one peculiar characteristic. Starting at approximately 30-microns diameter these tops depart from their normal curve in the fashion shown in Fig. 24. This departure shows the influence which trapping has on the top.

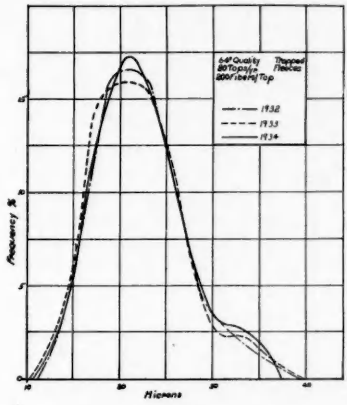


FIG. 25

Now it is doubtful whether or not trapping really has such a detrimental effect on quality as some manufacturers feel. If tops are to be spun to their limit-counts then, of course, such characteristics as the average commercial standard-top exhibits are troublesome; but, with current practice being not to spin tops anywhere near their limit-counts, it appears that no serious effect will be noticeable with either top. It must be remembered that the top of this diagram represents the bulk of tops of this quality sold, and should not be interpreted to mean that no tops are made without this characteristic. There are tops made which have diagrams lacking in this characteristic, but their volume is relatively small and they command a premium.

The curves in Fig. 25 illustrate the uniformity of a series of trapped tops over a period of years. The average of each year has the same characteristics. Since this type represents about 80% of the total top transactions in the United States, it would seem probable that a standard based on these tops would be representative of commercial practice in so far as this quality is concerned. Also, these tops are all made of United States Domestics and

Territories, so that they actually represent United States wool characteristics, and are comparable with all wools of this quality grown in this country.

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"Let others put the brakes on the pace of scientific progress to maintain 'social stability' if they think they must to prevent too rapid change. For us the course of science must be broadened—not arrested. In Sir Daniel Hall's Words, 'Sparta achieved social stability and died. The spirit of Athens is yet active in every field of human endeavor.'" From Address of Dr. Robert A. Millikan to U. S. Institute, Nov. 14, 1935.

Abstracts

This section is compiled under the direction of the Committee on Abstracts and Bibliography: Prof. E. R. Schwarz, Chairman, Dr. W. E. Emley, Prof. Louis A. Olney and M. W. Weiss.

I. Fibres (Synthetic and Natural) and Fibre Analysis

Bacterial Retting of Fibre Plants in Pure Cultures. I. A. Makrinov. *Dnevnik Vsesozuinogo Sezda Botanikov, Leningrad.* (*J. All-Russ. Congr. Bot. Leningrad*), 1928, V. 206, P. 1928 (through *Biol. Abs.*, 1934, V. 8, P. 163).

An abstract. The retting of flax by the aerobic *Pectinobacter amylophilum* gave the following results: Time of retting was greatly shortened, only 24–30 hrs. at 30–32° C. being required. The water remained clean, as this bacterium reduced about 75% of the pectin substances into CO_2 and H. Both quantity and quality of the flax were higher than by the ordinary method of retting. (From *J. T. I.*, Aug. 1935, P. A387.) (C)

Cellulose Acetate Rayon: Absorption of Tannin by. F. Jeanmot. *Rusta*, 1935, V. 10, P. 163–5, 234–7.

Tests of which details are given show that cellulose acetate rayon is capable of absorbing tannin. The amount absorbed increases with increasing concentration of the tannin solution employed and decreases with increasing temperature. Treatment of the rayon with swelling agents raises its capacity for absorbing tannin. The absorption appears to be a purely physical phenomenon and obeys the general distribution laws. The differences in the behaviour of viscose and cellulose acetate rayons towards tannin and the dyeing of tannin mordanted rayons with basic dyes is discussed. (From *J. T. I.*, Aug. 1935, P. A417.) (C)

Chemical Fibres. Gustavus J. Esselen. *Ind. Eng. Chem.*, 1935, V. 27, P. 642–7. (W)

Cotton: Estimation of Industrial Value of. Erich Wagner. *Monatschr. Textil-Ind.*, 1935, V. 50, P. 2–3, 26–7, 50–2.

The factors which must be considered in judging the quality of cotton are (1) the max. fibre length, (2) the av. fibre length, (3) the uniformity of the staple and (4) the no. of fibres in the cross-sectional area of the yarn. The importance and detn. of these factors are reviewed and various staple

diagrams and their frequency picture are shown. Fourteen references are cited. (From *C. A.*, 1935, V. 29, Col. 4589.) (W)

JUTE FIBRE: TENSILE STRENGTH OF. Pulin B. Sarkar. *J. Indian Chem. Soc.*, 1935, V. 12, P. 23–30; *C. A.*, 1935, V. 29, Col. 3844.

A special balance app. was designed for measuring the tensile strength of jute fibre after various treatments. The tensile strength diminishes with increasing moisture and vice versa. Storage in a dry place prevents deterioration. Delignified jute shows maintenance of strength and structure; this indicates that in jute, lignin and cellulose are not chemically combined. Formaldehyde increases the tensile strength, particularly in slightly alk. soln., and prevents bacterial decompn. of both raw and delignified fibre. Removal of lignin makes the fibre more susceptible to bacterial action. (W)

II. YARNS AND FABRICS

MOISTURE AND MILDEW ON TEXTILES. Anon. *Tex. Mfr.*, 1935, V. 60, P. 179; cf. I. D. Galloway, *J. T. I.*, V. 26, P. 4.

The tests made confirmed trade opinions that certain deliquescent substances caused mildew to grow more rapidly and in some cases at a slightly reduced humidity limit. This is due to the nutrient action of the deliquescent substance itself, such as glycerol, or a stimulation and consumption of other nutrients, such as $MgCl_2$, NaCl and KCl. (From *C. A.*, 1935, V. 29, Col. 5664.) (W)

PEBBLE AND TAKE-UP. C. W. Bendigo. *Tex. Wld.*, 1935, V. 85, P. 864.

The character of the pebble and take-up of rayon crepe fabrics can be varied by using different soaking formulas. (From *C. A.*, 1935, V. 29, Col. 4590.) (W)

PROPERTIES OF CLOTHING BASED ON PHYSIOLOGICAL STANDARDS. T. C. Angus. Report of Annual Meeting of British Association for Advancement of Science, Aberdeen, Sept. 1934, P. 288–9. (C)

RAYON YARNS: TAKE-UP DUE TO TWIST IN. H. E. Bishop, C. J. Huber and H. A. Mereness. *Rayon & Mell. Tex. Mo.*, 1935, V. 16, P. 149–52.

Data are given for 100, 150 and 200 denier rayon yarns with 5 to 70 turns of twist per in. A tension of 0.1 g. per denier was used since higher tensions were found to be detrimental. The percentage content of soaking oil (between 0.74 and 20.1% oil) had no practical effect on the twist take-up or permanent elongation of the yarns. The twist take-up does not appear to be affected by the type of the regenerated cellulose yarn, the finish, or the no. of filaments within each denier size. (From *C. A.*, 1935, V. 29, Col. 4590.) (W)